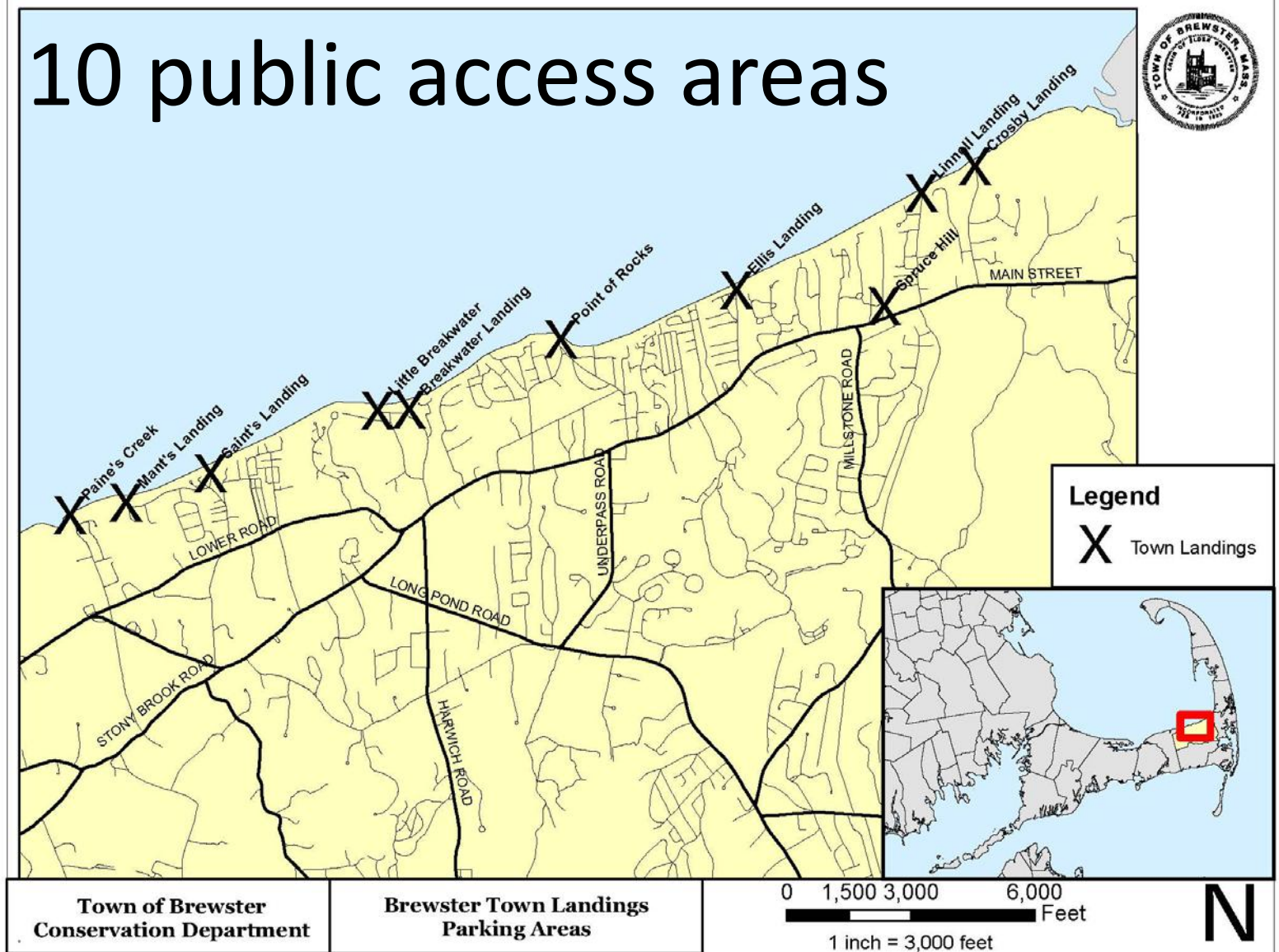


Long-term planning efforts to address landings in Brewster



10 public access areas



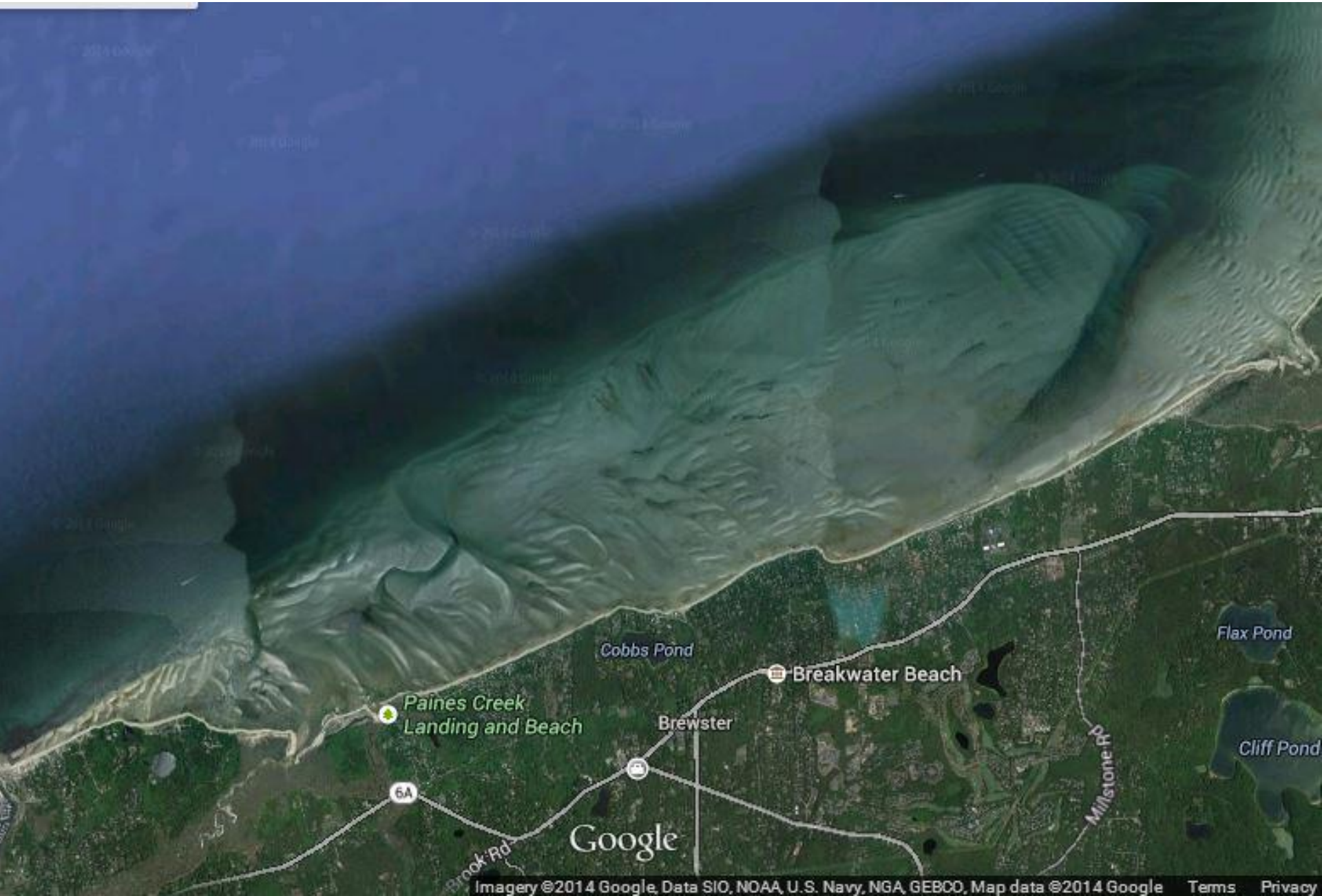
Parking spaces: Crosby 60, Linnell 25, Spruce Hill 12, Ellis 19, Point of Rocks 3 + 8, Breakwater 62, Little Breakwater 6, Saints 38, Mants 44, Paines Creek 19 =296.

The Brewster Flats

At low tide there are approximately 12,000 acres of exposed tidal flats extending up to two miles off shore in Brewster.



Brewster Flats



The Problems...

- Repetitive losses
- Erosion rates of up to 2 feet/year (15' in Sandy and related storms)
- Now, little or no buffer between infrastructure and the beach
- Loss of parking while increasing demand for access
- Rising sea level
- More severe storms, increasing frequency
- Higher rainfall amounts – poor stormwater infrastructure

The Approach

Brewster's approach:

- a comprehensive approach - assessment, planning, design
- integrating coastal science and technical information
- public participation
- a plan that will be the foundation for future Town actions

Recent coastal reports and recommendations

- 2003: Landing issues and recommendations report by Sea Grant/Barnstable County coastal specialist
- 2008: DPW state of landings with recommendations
- 2010: Natural Resources Coastal Atlas with status and recommendations
 - Updated 2011, 2013 , new update in 2015 underway
- Coastal storm video February 2013 (video on local access)
- Selectmen beach tour June 2013 (video on local access)
- CZM Grant reports (sediment study, beach profiles, photodocumentation, natural system monitoring, public outreach/education on erosion issues): fall 2015

How Brewster has Responded to Storm Damage to Date

- Purchase of coastal salt marsh and extensive open space
- Removal/restoration of coastal restrictions
 - Namskaket under bike trail, new culvert in 2007
 - Quivett Creek culvert under Sea Street in 2006
 - Rt. 6A culvert at Paines Creek 2009 (ARRA grant)
 - Freemans Pond culvert 2013
- Paines Creek parking lot project
- NRCS, state stormwater grants
 - Watershed approach, protect shellfish beds.
 - From headwater Mill Pond complex to shore at Stony Brook/Paines Creek

Coastal Adaptation Project

- Measuring the volume, rate and direction of sand movement of Brewster's entire coast, i.e. a sediment budget
- Photo-documenting and habitat monitoring at each coastal Landing;
- Engineering evaluation of each Landing and beach
- Developing short and longer term management recommendations based upon condition of landing, sand movement and the natural systems surrounding each location.
- Designing a major coastal retreat design for Breakwater, one of the largest beach parking lots, including restoring former parking areas to coastal dune and green stormwater control;
- Designing for a measured retreat at two landings, [Ellis Landing and Mant's Landing] that have suffered significant repetitive losses

Sediment Budget study

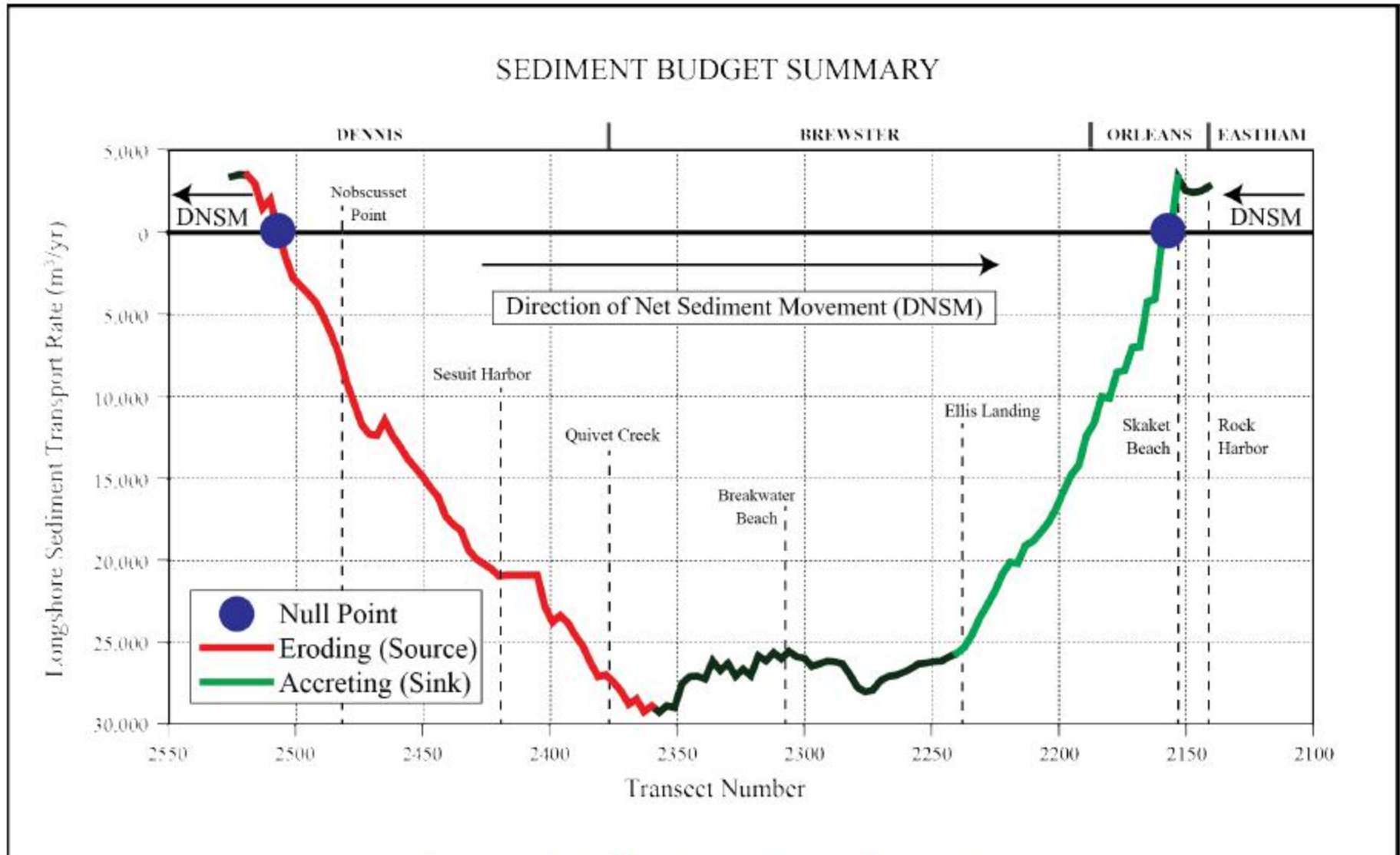


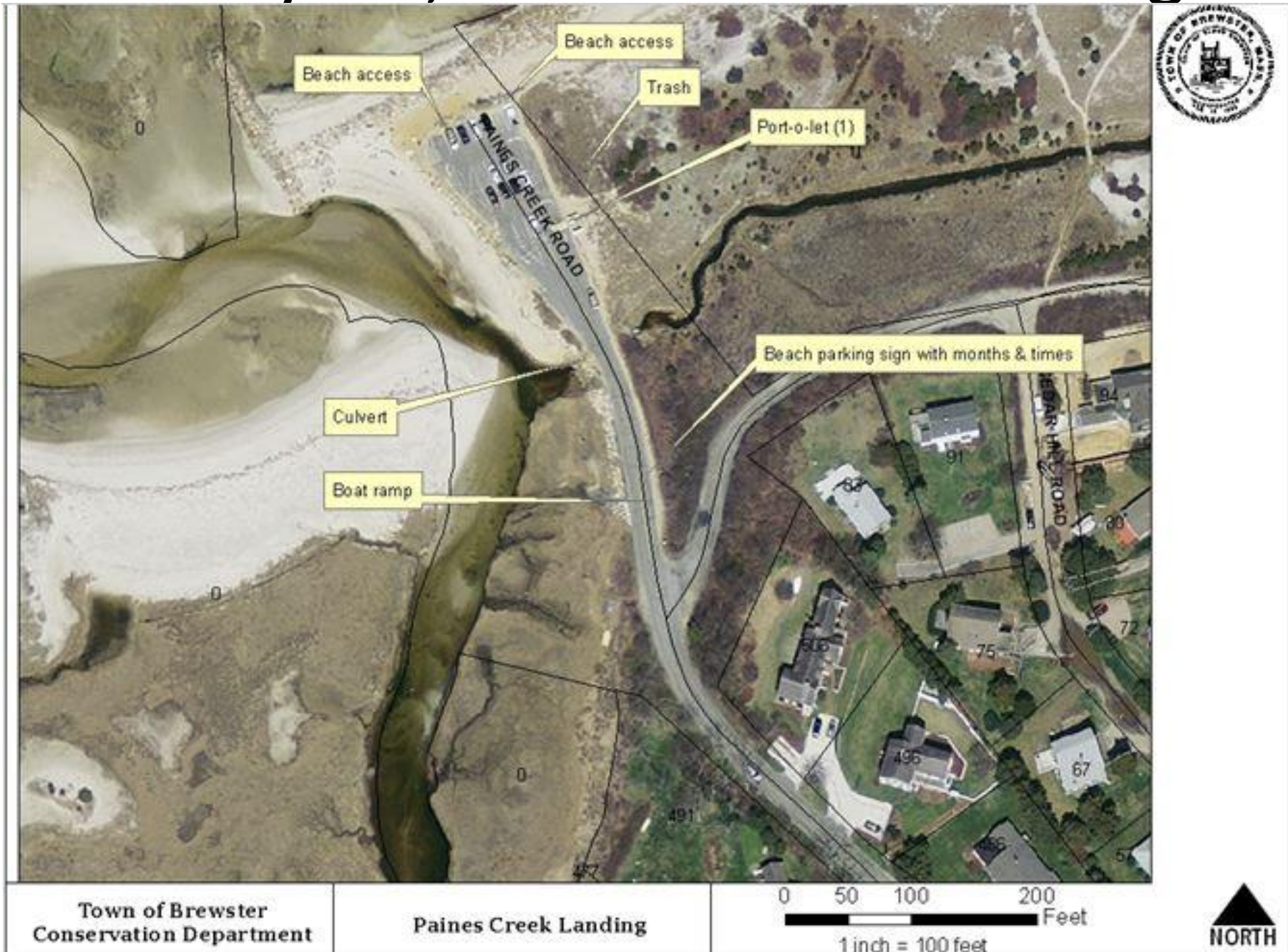
Figure 8: Distribution of Q for all transects.

Paines Creek Landing



Figure 1. 2005 aerial of Paines Creek Beach, Brewster, MA (Mass GIS).

Old layout, Paines Creek Landing



New Layout Paines Creek Landing





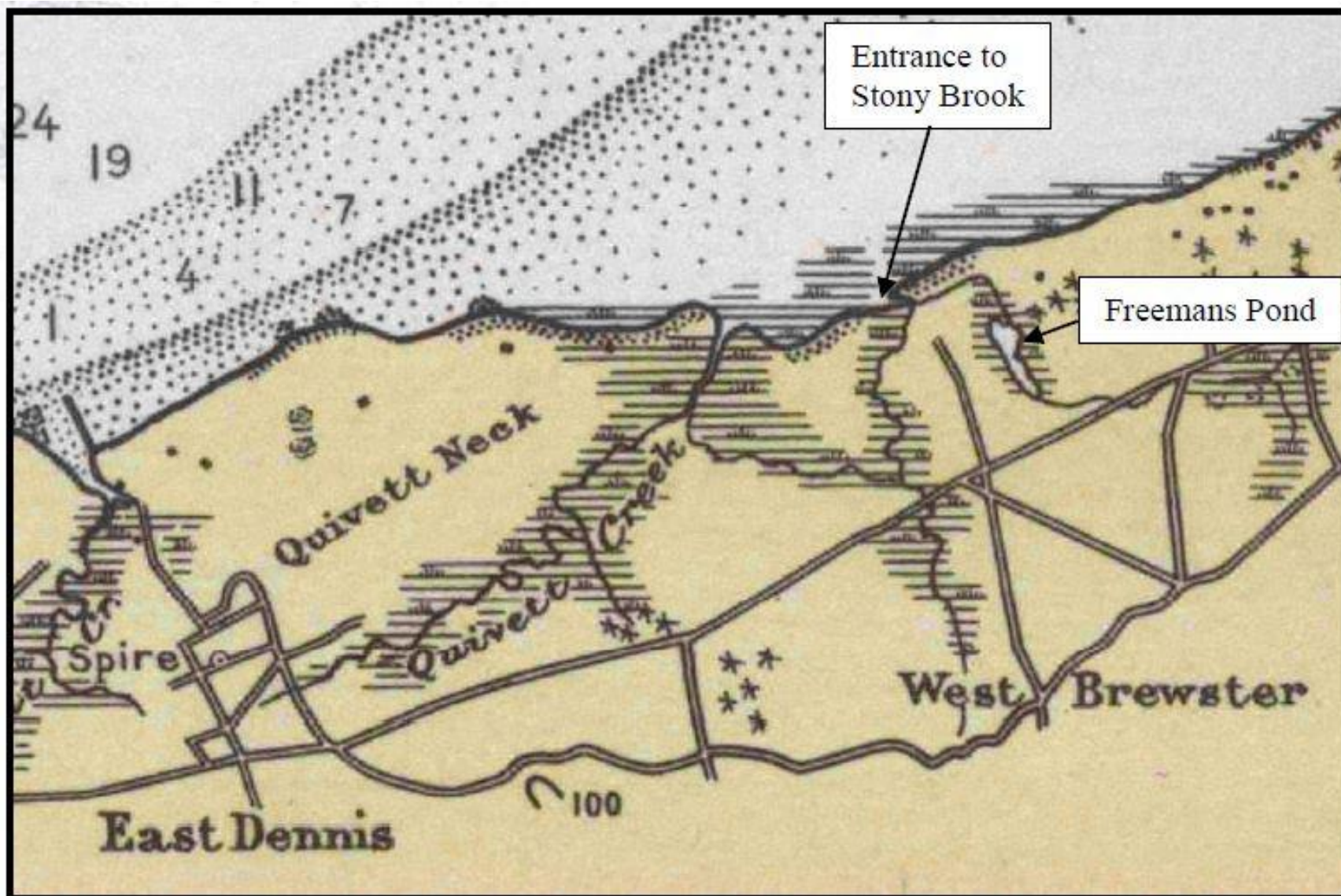


Figure 16. Portion of Nautical Chart No. 1208, Cape Cod Bay published by the U.S. Coast and Geodetic Survey in 1933 (Mass GIS).

2009



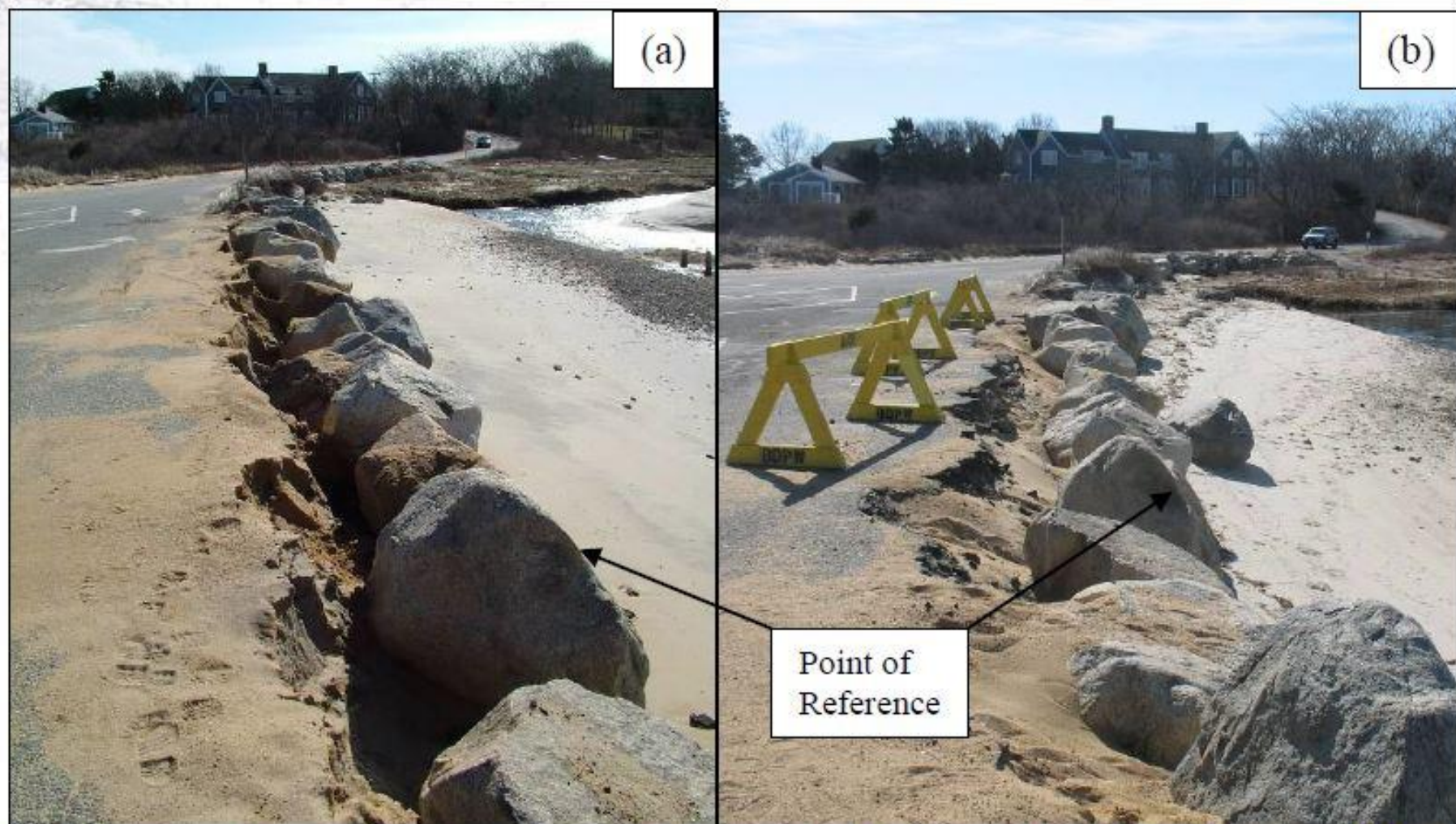


Figure 7. Progressive erosion occurring at western end of Paines Creek Beach parking area. Panel (a) is photo taken on February 13, 2009 (looking southeast) while panel (b) shows same view taken on March 26, 2009.

January 20, 2010





2010: AmeriCorp places over 1,000 sandbags, extensive renourishment with sand, repaving. Additional winter storms damaged sand bags, removed more sand, damaged more parking lot.



Stormwater erosion from parking area at southeast side on March 14, 2010.

2011

- Repeat of 2010, with extensive damage to parking area, loss of pavement and asphalt fragments throughout beach and creek.
- AmeriCorp helps install another 1,000 sandbags to shore up area.
- Very short term repair, additional damage in spring.





Table 5. Alternatives analysis for shoreline protection at Paines Creek Beach

ALTERNATIVE	Overall Effectiveness	Shoreline Stabilization	Structural Lifetime *	Permitability	Permitting / Engineering Cost	Construction Cost *	Construction Feasibility	Maintenance Requirements
1. Do Nothing	○	○	N/A	N/A	N/A	N/A	N/A	○
2. Stone Revetment	●	●	●	◉	◉	○	●	●
3. Vertical Wall/bulkhead (timber/steel/composite)	●	●	●	○	○	○	◉	●
4. Rock-filled Gabion Baskets	◉	◉	◉	○	○	○	◉	◉
5. Coir Logs	◉	◉	○	●	●	●	◉	◉
6. Cobble Berm	◉	○	○	◉	◉	◉	●	○

* = Relative to other alternatives, varies depending on alternative items and local costs

● = Good

◉ = Medium

○ = Poor

N/A = Not Applicable

NRCS Stormwater Grants

- Saints Landing
- Paines Creek Road – North
- Paines Creek Road – South, including town landing
 - Instead of capturing and infiltrating stormwater at beach parking lot, we considered the retreat alternative, restoring the dune and building a similar sized lot in the road layout further inland.



Coastal Retreat

- Repetitive losses, high cost
- Environmental damage (asphalt/fill etc.)
- Long term likelihood of failure with rising seas and increasing storm intensity
- Hard solution would not be allowed
- Any permanent wall would result in loss of beach

Stormwater

- NRCS grant requires 75 year life for structure.
- Stormwater basins in a dune?
- Instead, repurpose grant to remove asphalt, restore to natural habitat, reconstruct a smaller and better designed and resilient parking area.

Winter storm "Nemo" in 2013







Sandy and Nemo

- Since parking lot retreat, several severe storms.
- Old parking lot would have likely suffered extensive damage, if not completely destroying it.
- Restored area lost a lot of beach sand.
- New parking area inundated but minimal damage.

Freemans Pond Culvert



Figure 9. Seaward end of culvert connecting Stony Brook with Freemans Pond showing deteriorating embankment protection (photo taken January 23, 2009).







Stony Brook



Google

Paines Creek Footbridge

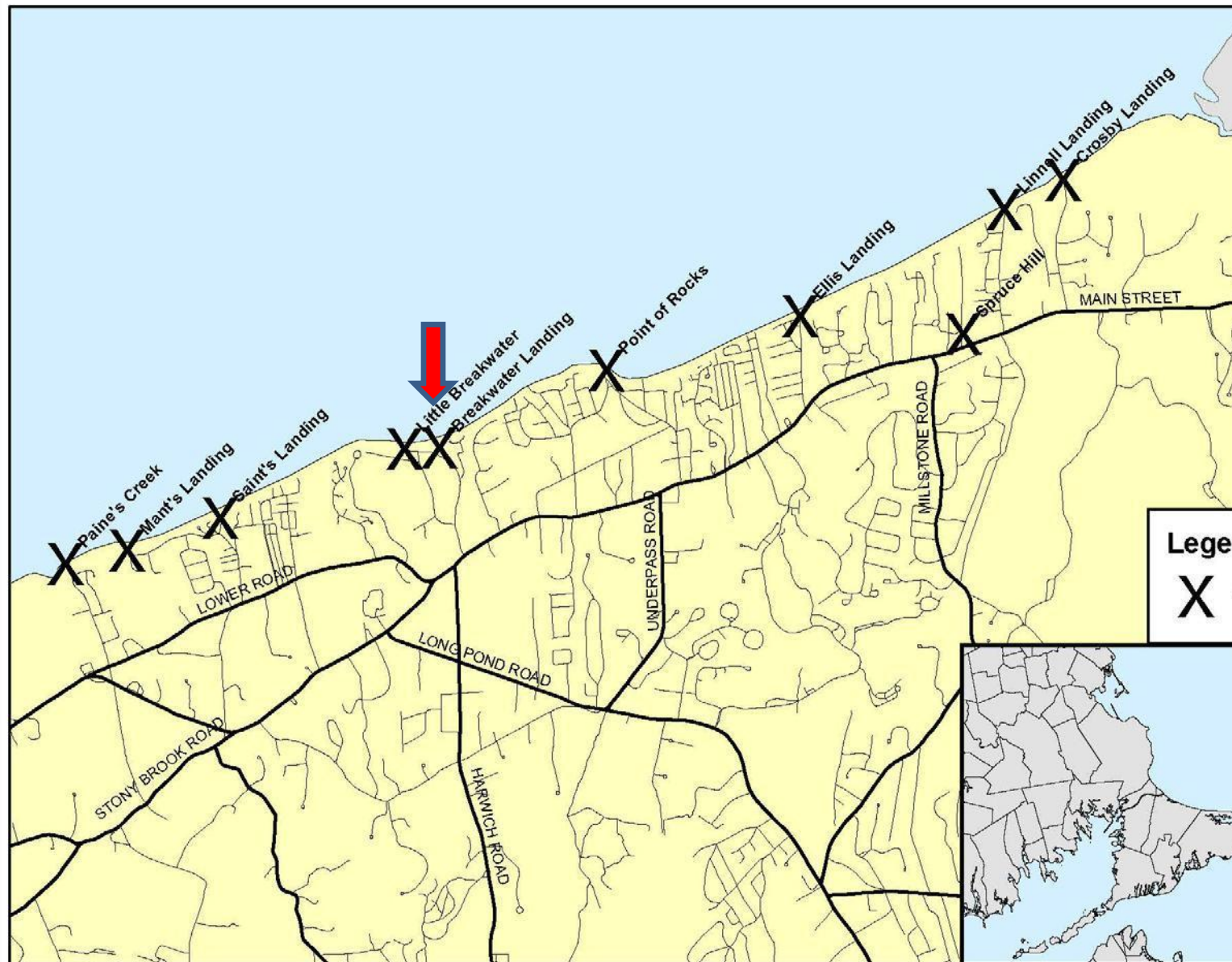
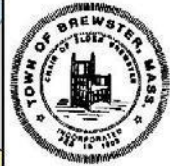


DATUM CONVERSIONS

MLLW	NAVD88	MLW
12.70'	HTL - 6.85'	HTL - 12.43'
10.08'	MHW - 4.23'	MHW - 9.81'
5.85'	NAVD88 0.0 - 0.00'	NAVD88 0.0 - 5.58'
0.27'	MLW - 5.58'	MLW - 0.00'
0.0'	MLLW - 5.85'	MLLW - 0.27'



Provides access to the center of the 1,600 foot plus public beach between Mants and Paines.



Legend

X Town Landings



**Town of Brewster
Conservation Department**

**Brewster Town Landings
Parking Areas**

0 1,500 3,000 6,000
Feet
1 inch = 3,000 feet

N

Breakwater Beach Resiliency Design

- **Relocation of Breakwater Landing Beach Parking Area, Restoration of Beach and Dune Habitat, Green Stormwater Infrastructure:**
 - **Outputs:** 100% design plans and bidding documents for removal and relocation of the parking lot, restoration of habitat, and improved access paths.
- **Green Infrastructure grant** awarded for construction: \$155,000 plus town match of \$59,675 (CPC spring 2014) and \$10,000 (fall 2014).

Breakwater Bath house c.1900



Breakwater Beach Bath Houses c.1900

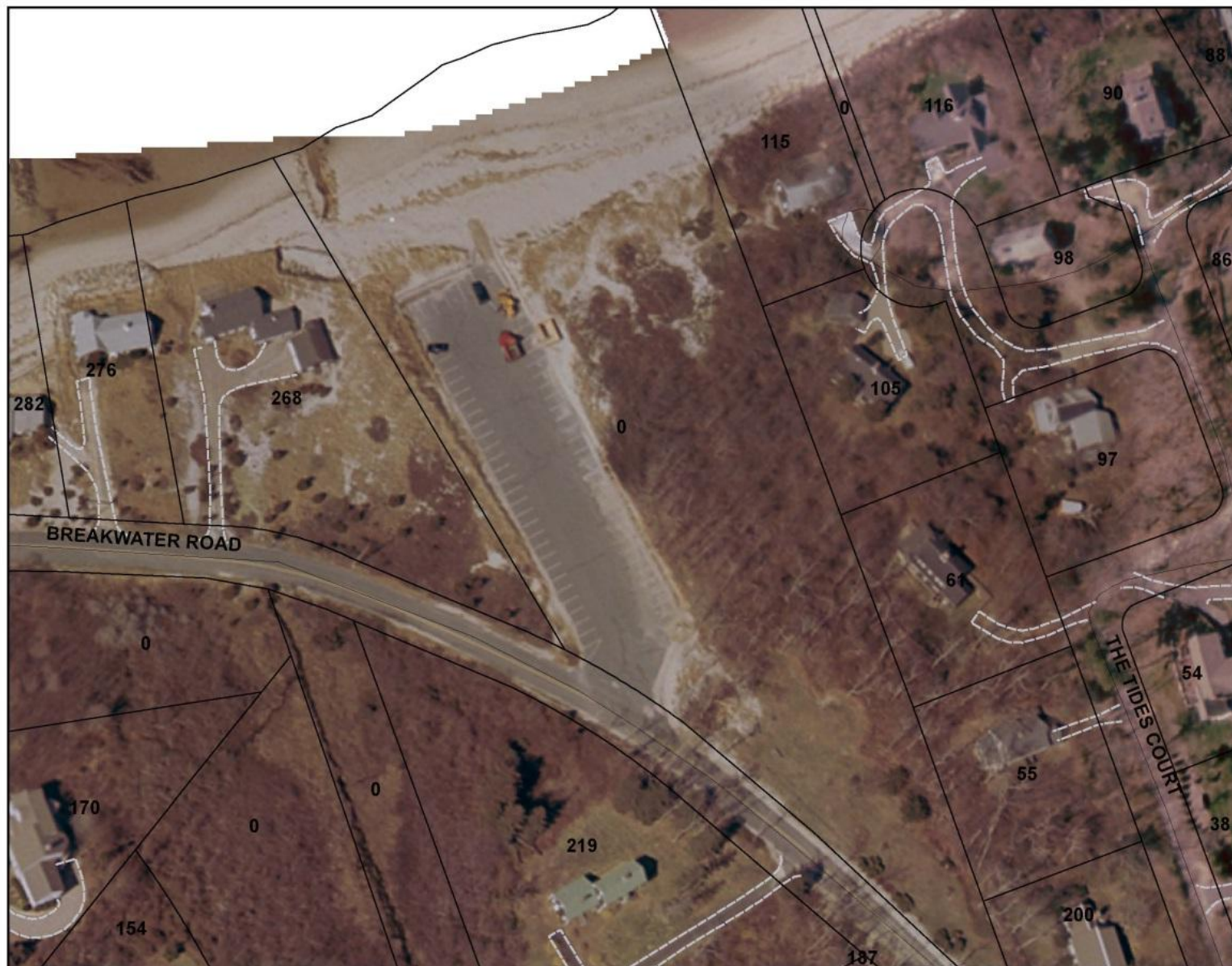
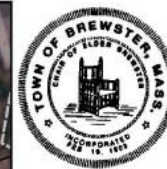


Some of these bath houses were owned by the town, with the town collecting the rent (in 1930 about \$7 for the summer), and some were privately owned. The last bath houses were torn down in 1945 when the property was sold.









**Town of Brewster
Conservation Department**

Breakwater

0 50 100 200
Feet
1 inch = 100 feet

N

Breakwater January 3, 2010



Breakwater –Rebuilding/replacing the artificial dune in January 2010





Breakwater March 3, 2010.

Winter storms removed remnants of dune north end of parking lot, causing the lot to be undermined. January 2010, sand was placed to provide additional protection for the remainder of the winter. The sacrificial dune was destroyed; additional parking area was lost. The parking lot elevation is low, and unless protected, we may expect additional loss of pavement each year, in part due to the lack of sediment transport from further west (revetments and groins).

Breakwater March 2010





March 3, 2010

Stormwater currently collects in the northwest corner of the lot, causing erosion of the dune as it moves north onto the beach. At times this forms a deep very large puddle, forcing a hole through the dune over time. The grant proposal would eliminate the direct stormwater discharge onto the beach, reduce the volume of stormwater generated, and treat the stormwater through natural bio-swales or porous pavement.

Breakwater May 2010



April 2011 dune restoration with Brandeis students







Winter 2012/2013



NO DOGS.
BANNED IN PARK
AT ALL TIMES
May 1 to October 1
For more information
visit the park website
www.park.com

Winter 2012/2013





March 7, 2013



Breakwater spring 2013





March 26, 2014

Storm left debris, wrack and eroded sand from base of dune at sturdy sand fence located at north end of parking lot at Breakwater.



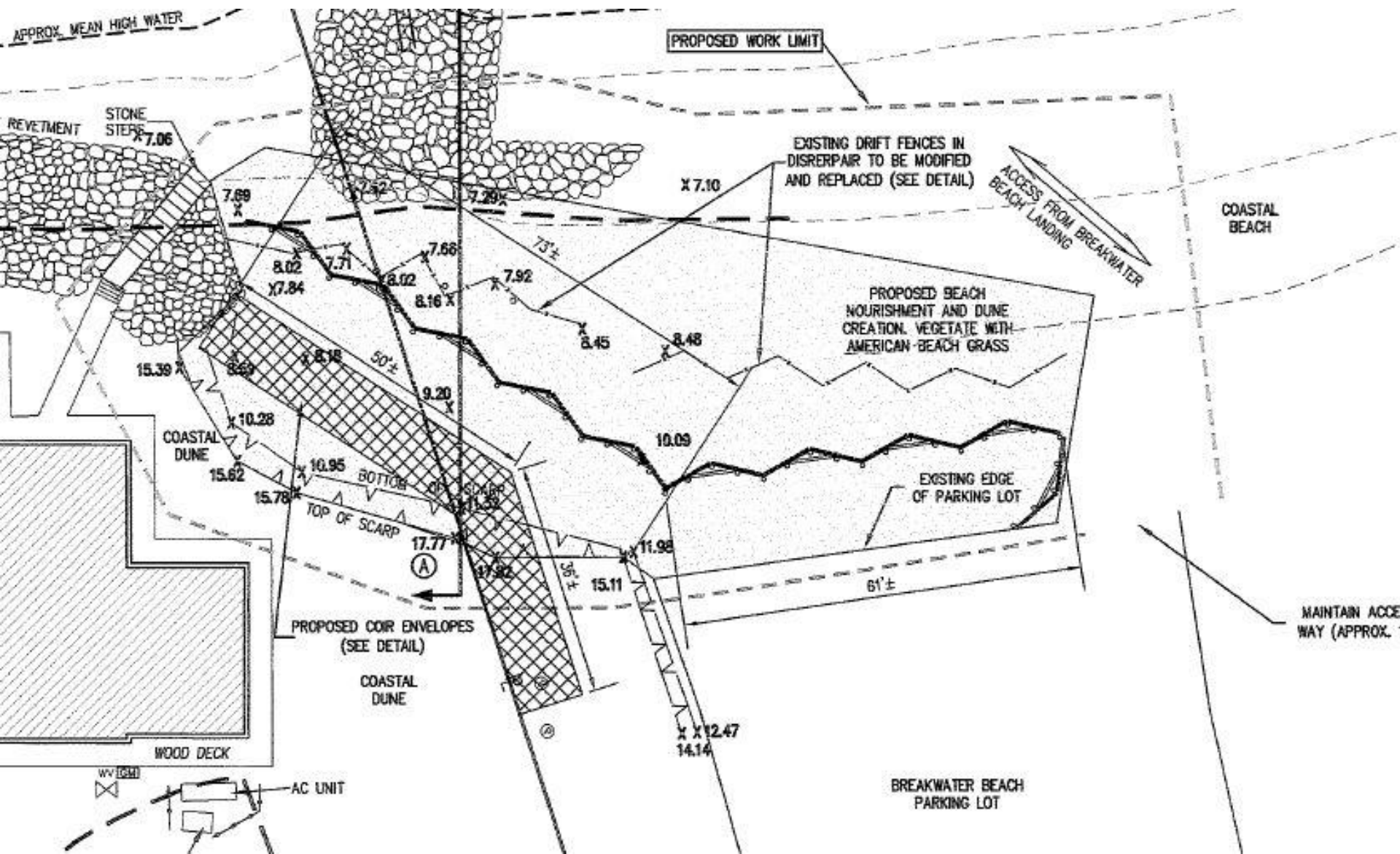
March 26, 2014

Storm left wrack and wind and wave born sand into paved parking area at Breakwater.

Since 2010

- Much larger sacrificial dune supported by sturdy sand fence
- Beach grass planted on dune to add resiliency
- Size of dune allows infiltration of stormwater without a “blow out” through dune or entrance.
- Neighbor to west improves end of revetment with reinforced coir logs, sand nourishment, sturdy sand fence.

End scour from revetment to west



April 2, 2014

Sturdy sand fence (green oak timbers) prior to burying with beach sand. Note coir envelope protecting adjacent house west of landing.



Sturdy sand fence in sacrificial dune at Breakwater

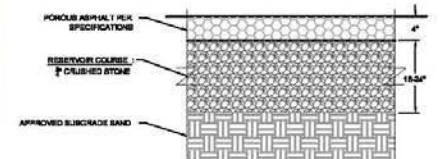
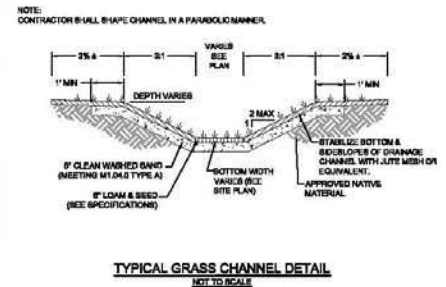




Sturdy fence buried under new dune located slightly further from active beach.



last modified: 01/17/14 printed: 01/17/14 H:\Projects\2011\1109 Brewster Int. Wtr. Res. Mgt Plan\Drawings - 1109\140113_BREAKWATER CONCEPT_1109.dwg



GENERAL NOTES:

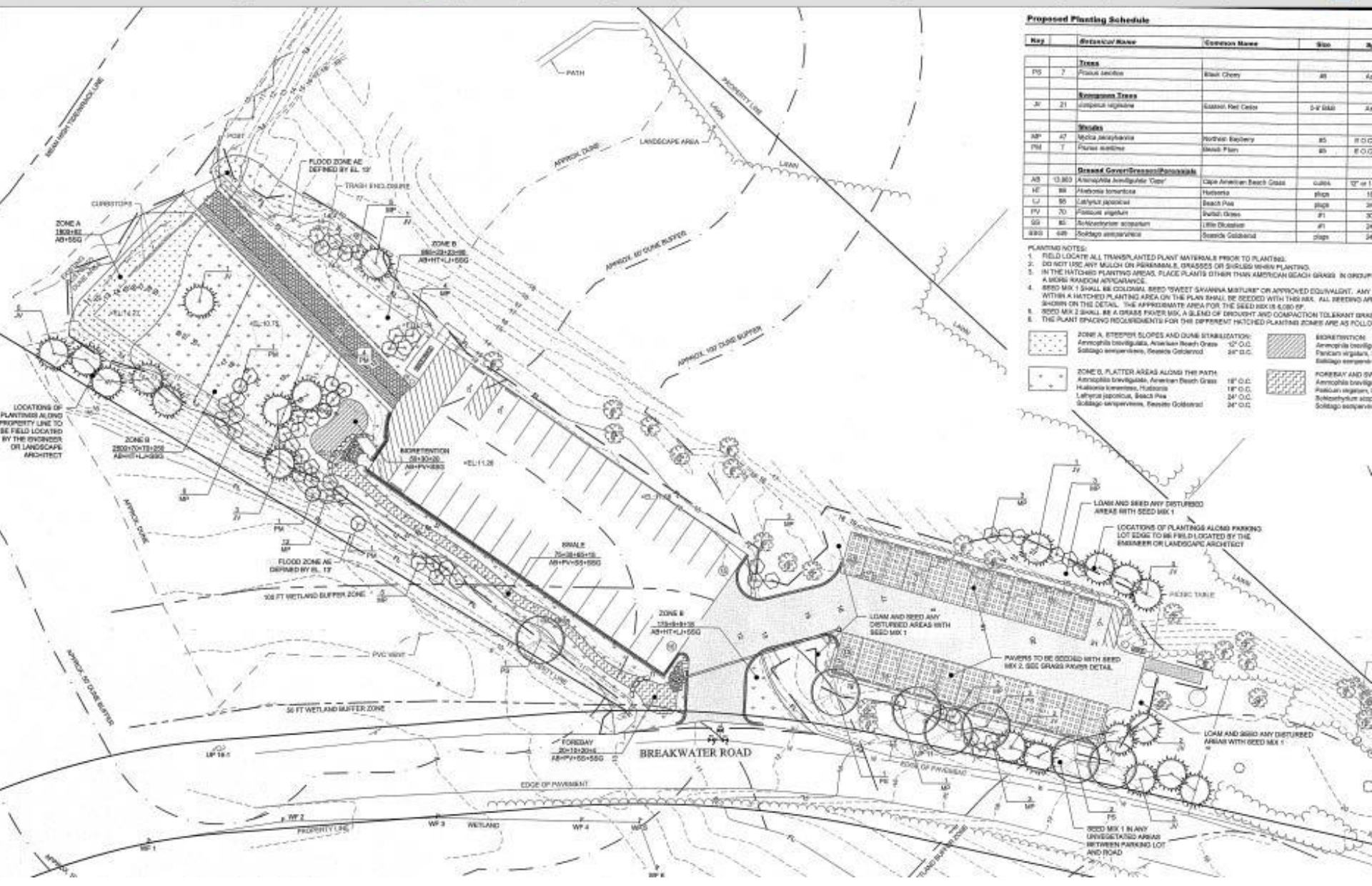
1. BANCY LOAM AND/OR LOAMY-BAND TOPSOIL MATERIAL SHALL BE EXCAVATED FROM ALL PAVED AREAS PRIOR TO CURBAGE INSTALLATION.
2. SUB-CURVE (EXISTING NATURAL) SHALL CONSIST OF NEFT MATERIAL THAT IS HARD, DURABLE, NON-ABSORBENT, BOUND, FREE FROM LOAM AND CLAY TO A DEPTH NOT LESS THAN 4" BELOW THE FINEST PAVEMENT BUREL.
3. PAVEMENT FILL SHALL BE COMPACTED TO 90% COMPACTION UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
4. SEE BITE LAYOUT PLAN FOR PAVEMENT WIDTH AND LOCATION.
5. SEE GRADING PLANS FOR PAVEMENT SLOPE AND CURBAGE SLOPE.

TYPICAL POROUS ASPHALT CROSS-SECTION

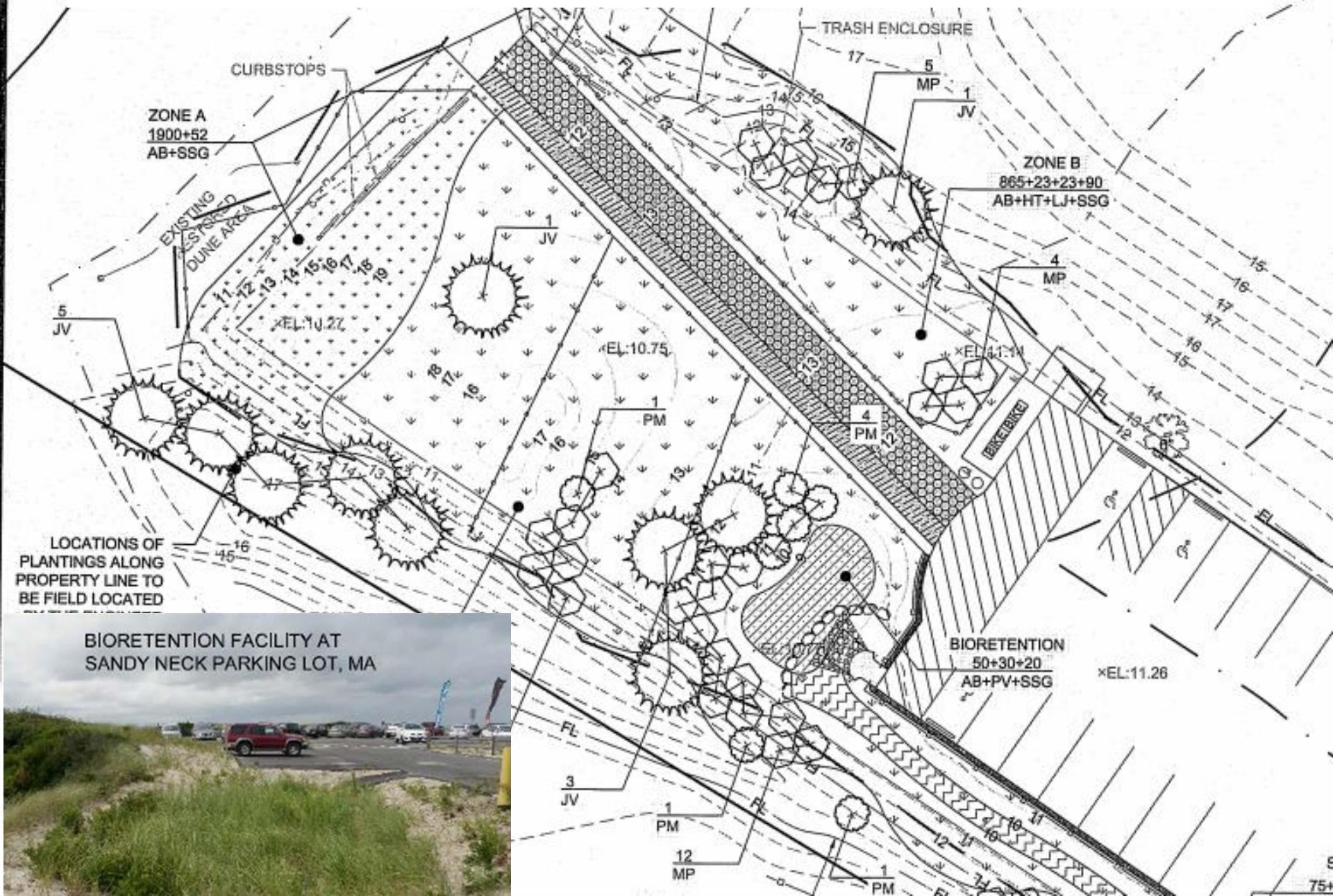
NOT TO SCALE



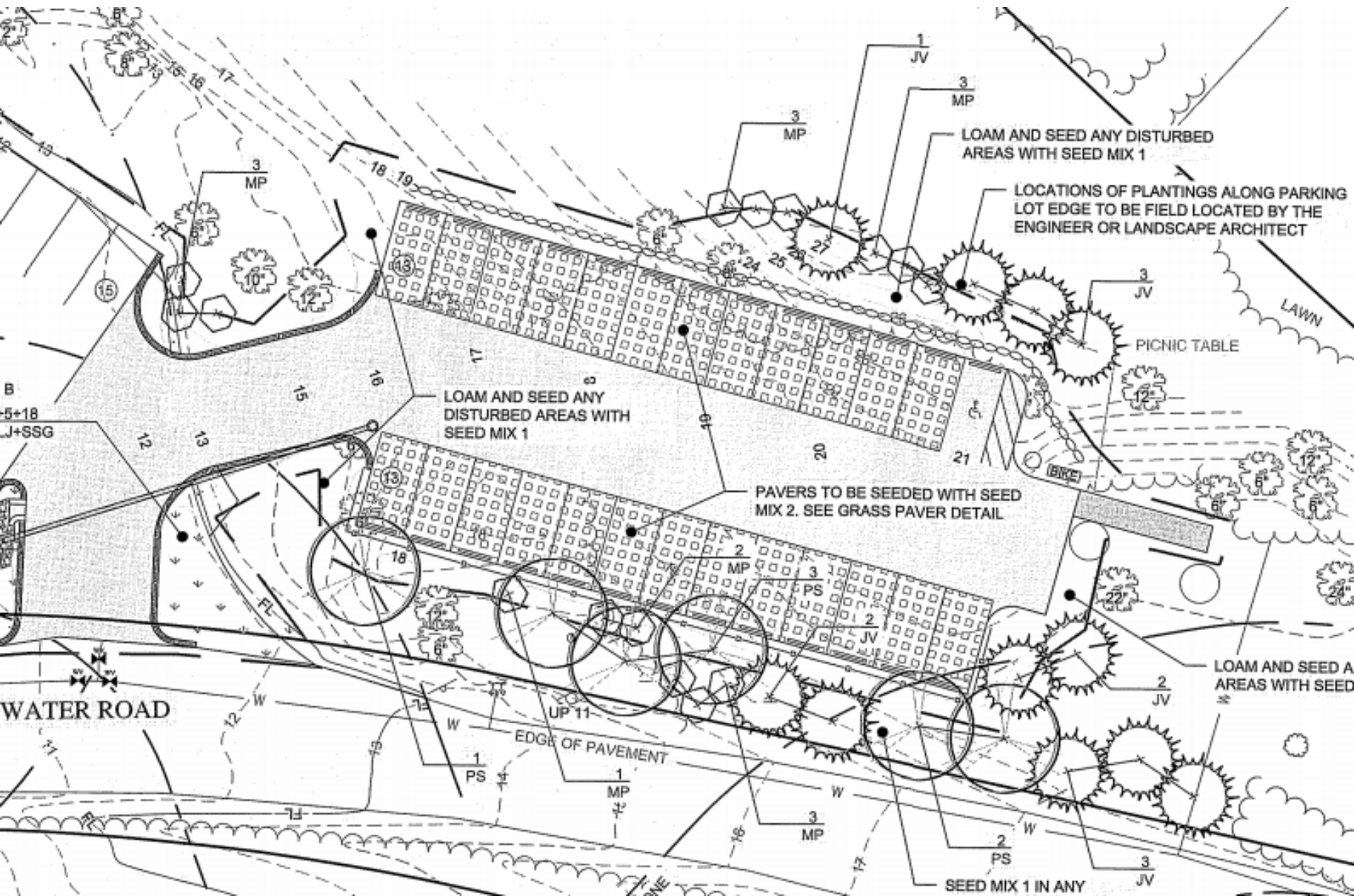
Final revised plan



Concept: Retreat and rebuild



New replacement lot

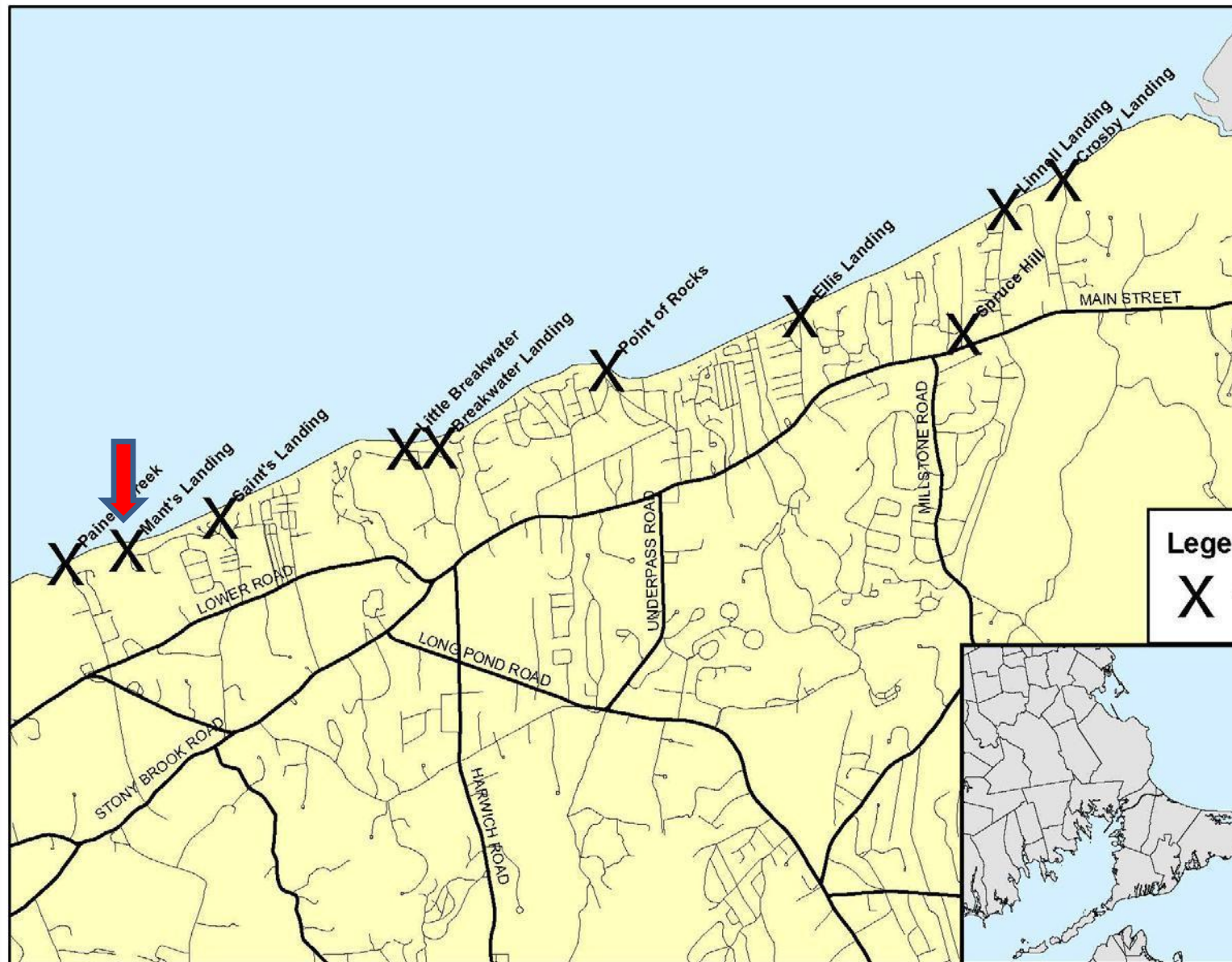


Details

- Restore area to coastal dune, add beach sand to increase elevation to match surrounding, plant beach grass and shrubs.
- Articulating concrete mat under sand to allow vehicle traffic access through dunes for emergency response, coastal nourishment projects.
- Seasonal boardwalk through dunes to beach.
- Interpretive displays.

Adaptive Management of Mant's Landing:

- The paved parking area at Mant's Landing Beach is located in a dune at a very low elevation, and suffers from repetitive storm damage.
- Use of a removable flexible articulating concrete mat as an interim replacement for a paved parking area on a beach until a permanent solution can be found.
- Raise grade at rear of property to lessen flooding



Legend

X Town Landings



**Town of Brewster
Conservation Department**

**Brewster Town Landings
Parking Areas**

0 1,500 3,000 6,000
Feet
1 inch = 3,000 feet

N

Articulating concrete mat



Blocks connected with flexible cable



Mants May 2010



Imagery Date: 5/20/2010 41°45'44.00" N 70°06'33.14" W elev 9 ft

Mants March 2010



January 2013 Mants



Winter storm removed sacrificial dunes. Rebuilt in early February 2013.

Mants February 2013



Nor'easter Nemo. Dunes destroyed, parking lot asphalt lifted and damaged.



Mants Landing March 2015







LEGEND

	PROPOSED NEW STRUCTURE
	EXISTING STRUCTURE
	PROPOSED NEW STRUCTURE
	PROPOSED NEW STRUCTURE
	PROPOSED NEW STRUCTURE
	PROPOSED NEW STRUCTURE
	PROPOSED NEW STRUCTURE
	PROPOSED NEW STRUCTURE
	PROPOSED NEW STRUCTURE
	PROPOSED NEW STRUCTURE

EXISTING CONTOURS

Feet	Feet	Feet
10.00	10.00	10.00
10.00	10.00	10.00
10.00	10.00	10.00
10.00	10.00	10.00
10.00	10.00	10.00

- NOTES**
1. All work shall be in accordance with the Massachusetts Department of Transportation (MassDOT) Standard Specifications for Highway Construction, 2011 Edition, and the Massachusetts Department of Transportation (MassDOT) Standard Specifications for Highway Construction, 2011 Edition, and the Massachusetts Department of Transportation (MassDOT) Standard Specifications for Highway Construction, 2011 Edition.
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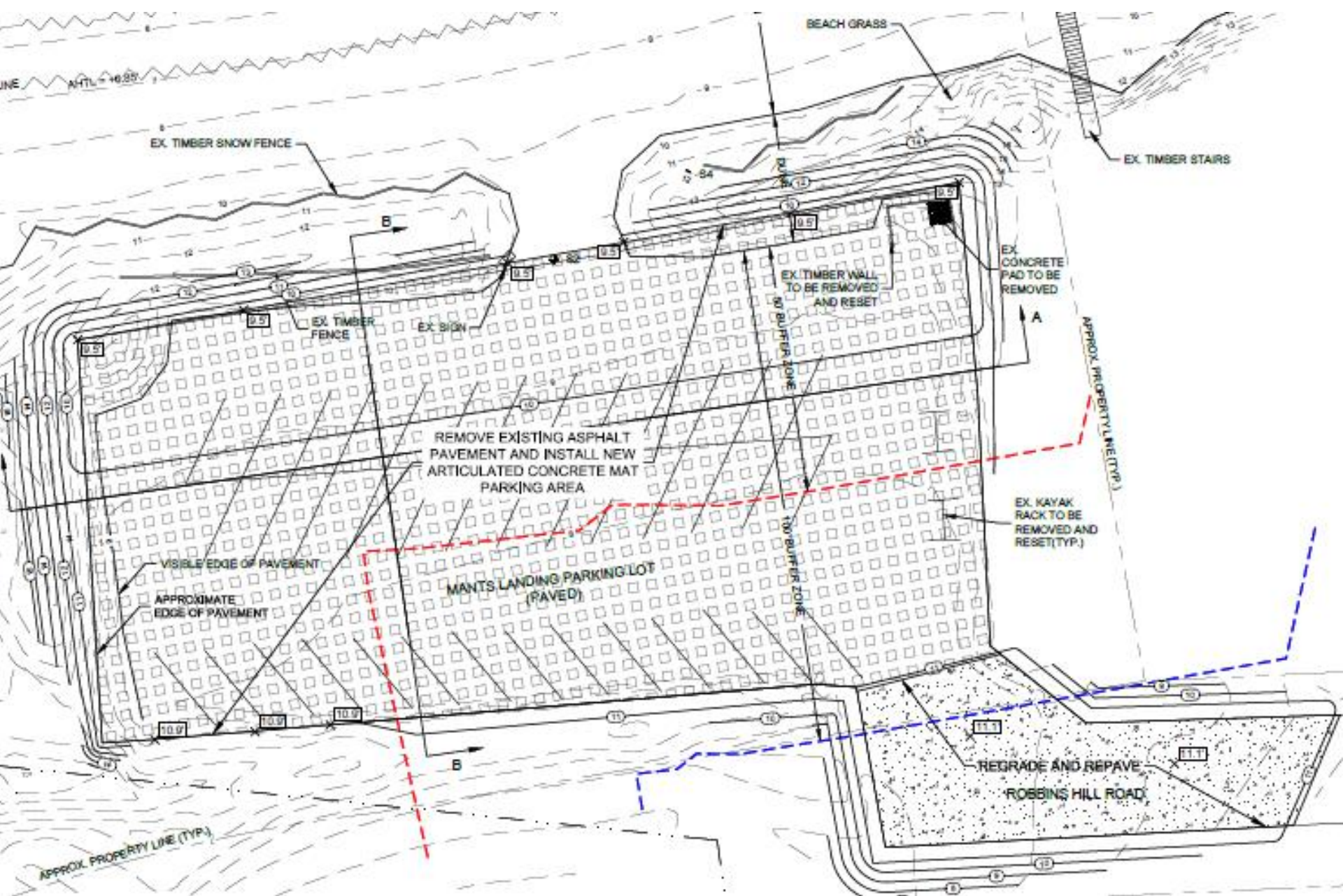
PROJECT **MANT'S TARTING**
ROCKWELL, MASSACHUSETTS

OWNER **TOWN OF BARNSTABLE**
2196 MAIN STREET, BARNSTABLE MA 02603

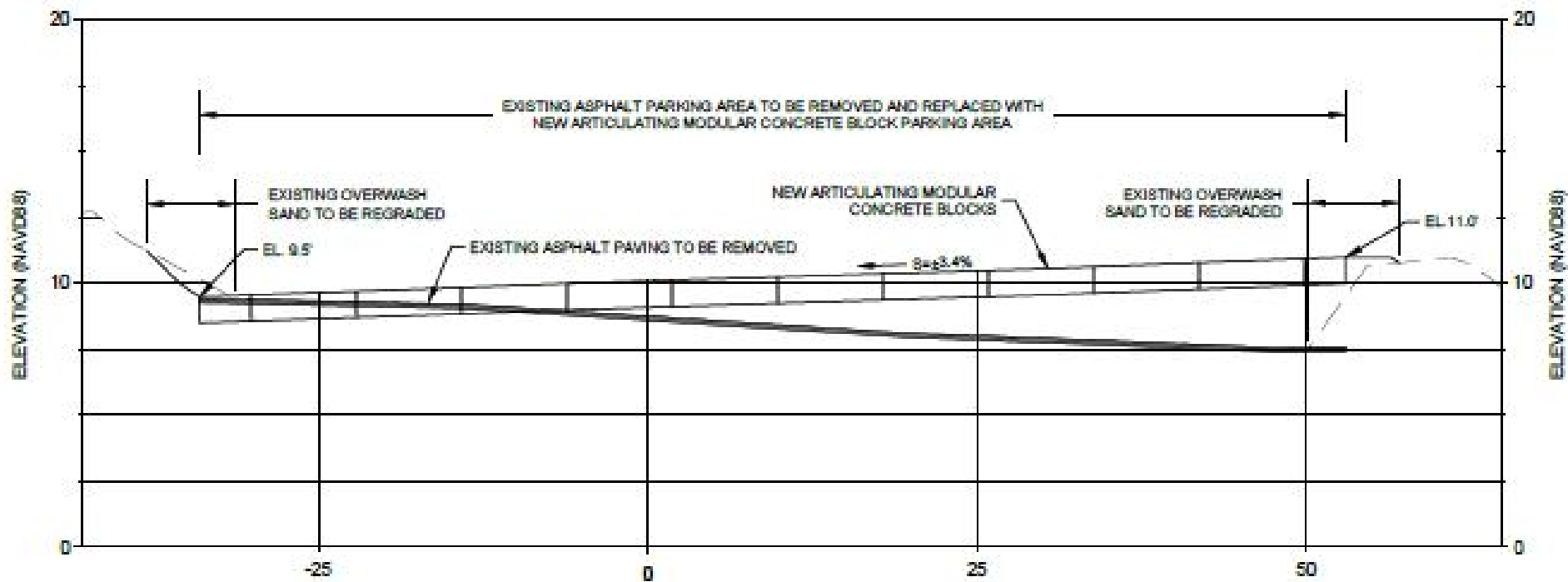
designengineering
 11 Green Road | North Barnstable, MA 02796
 P 508.748.0947 | www.designengineering.com

MANT'S TARTING **SHEET 1 OF 2**
PLAN

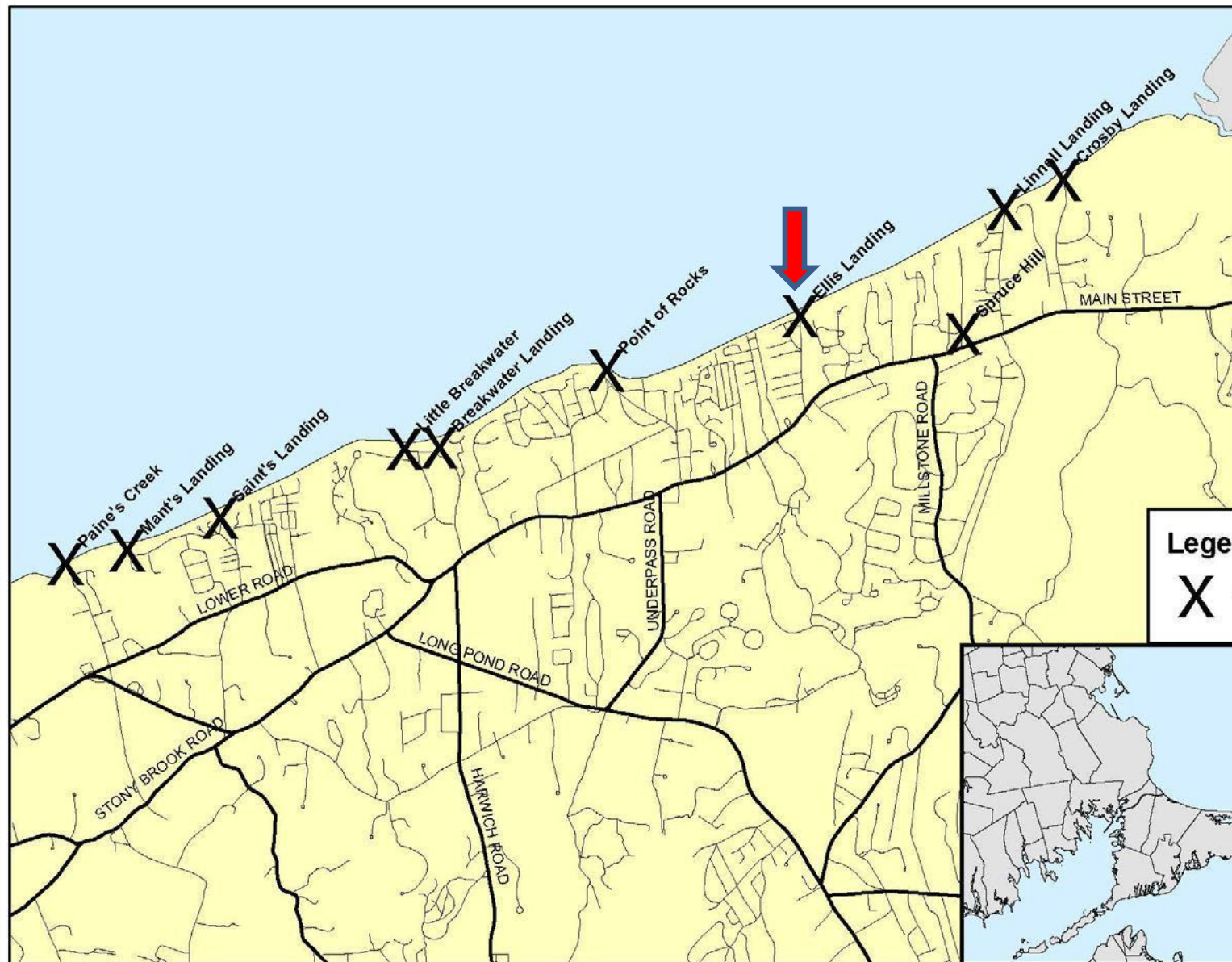
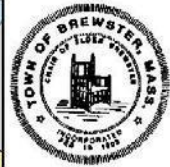
DATE	BY	CHECKED	DATE



Beach to left (North)



TYPICAL SECTION B-B
HORIZONTAL SCALE: 1"=10'
VERTICAL SCALE: 1"=5'



Legend

X Town Landings



**Town of Brewster
Conservation Department**

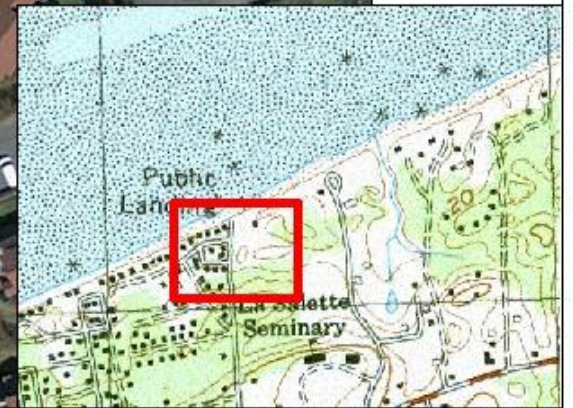
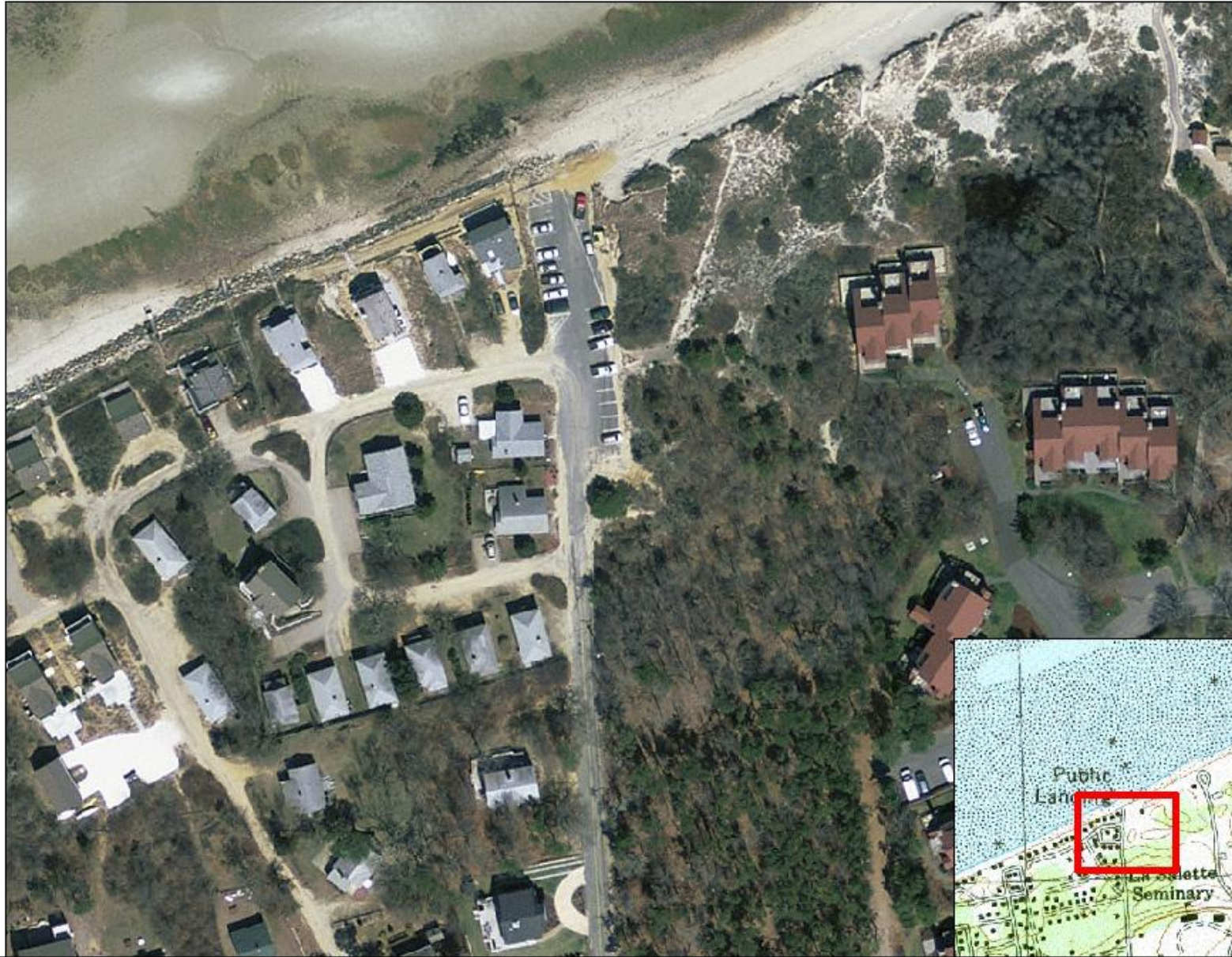
**Brewster Town Landings
Parking Areas**

0 1,500 3,000 6,000
Feet
1 inch = 3,000 feet

N

Planning and Design for Managed Retreat at Ellis Landing

- Provide sustainable public access that minimizes or avoids impacts on habitat, and reduce the risk of damage and need for continued public investment.



Ellis Landing March 2010



Ellis February 2011



Ellis May 2012 stormwater

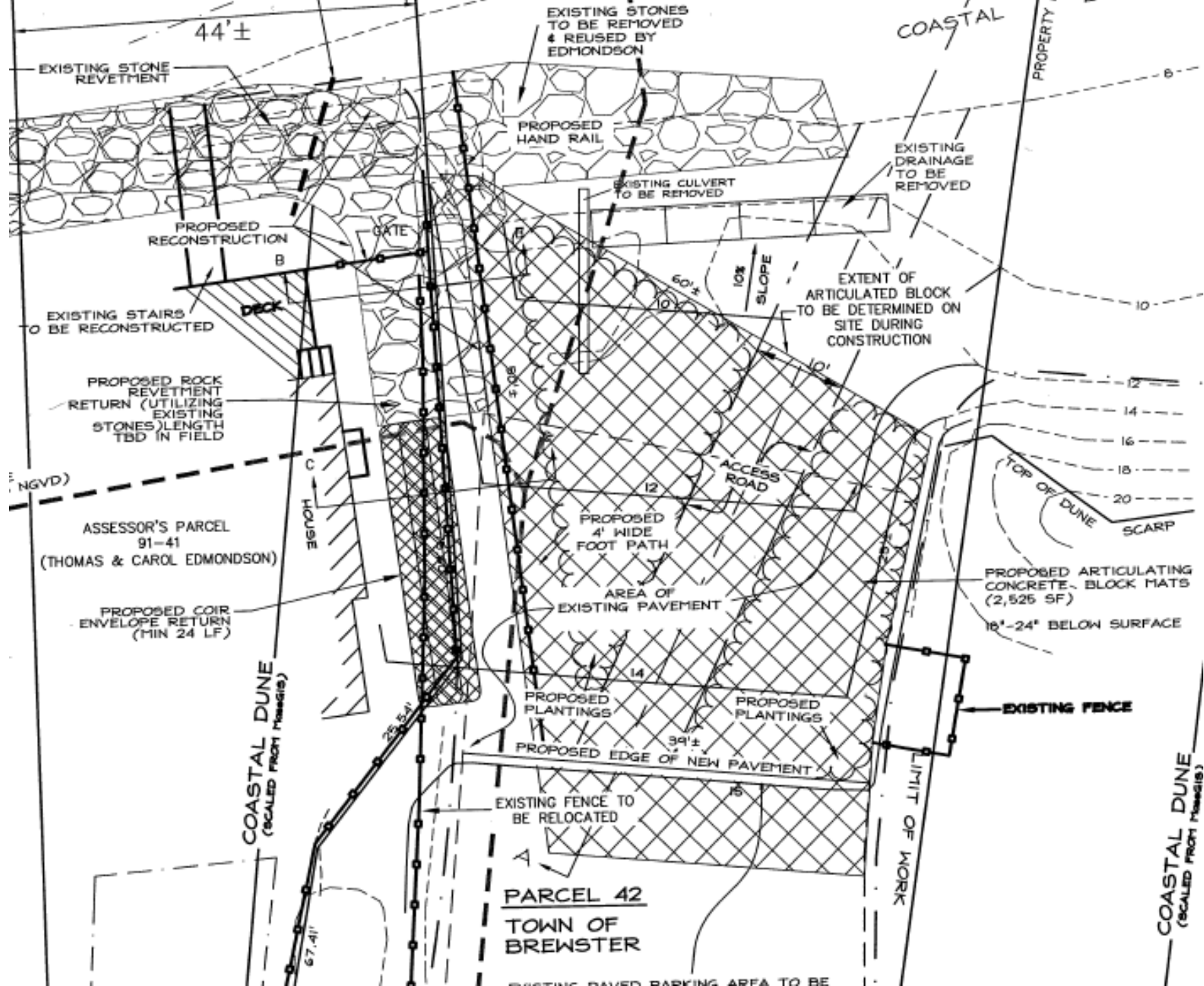


February 2013



Ellis March 2014





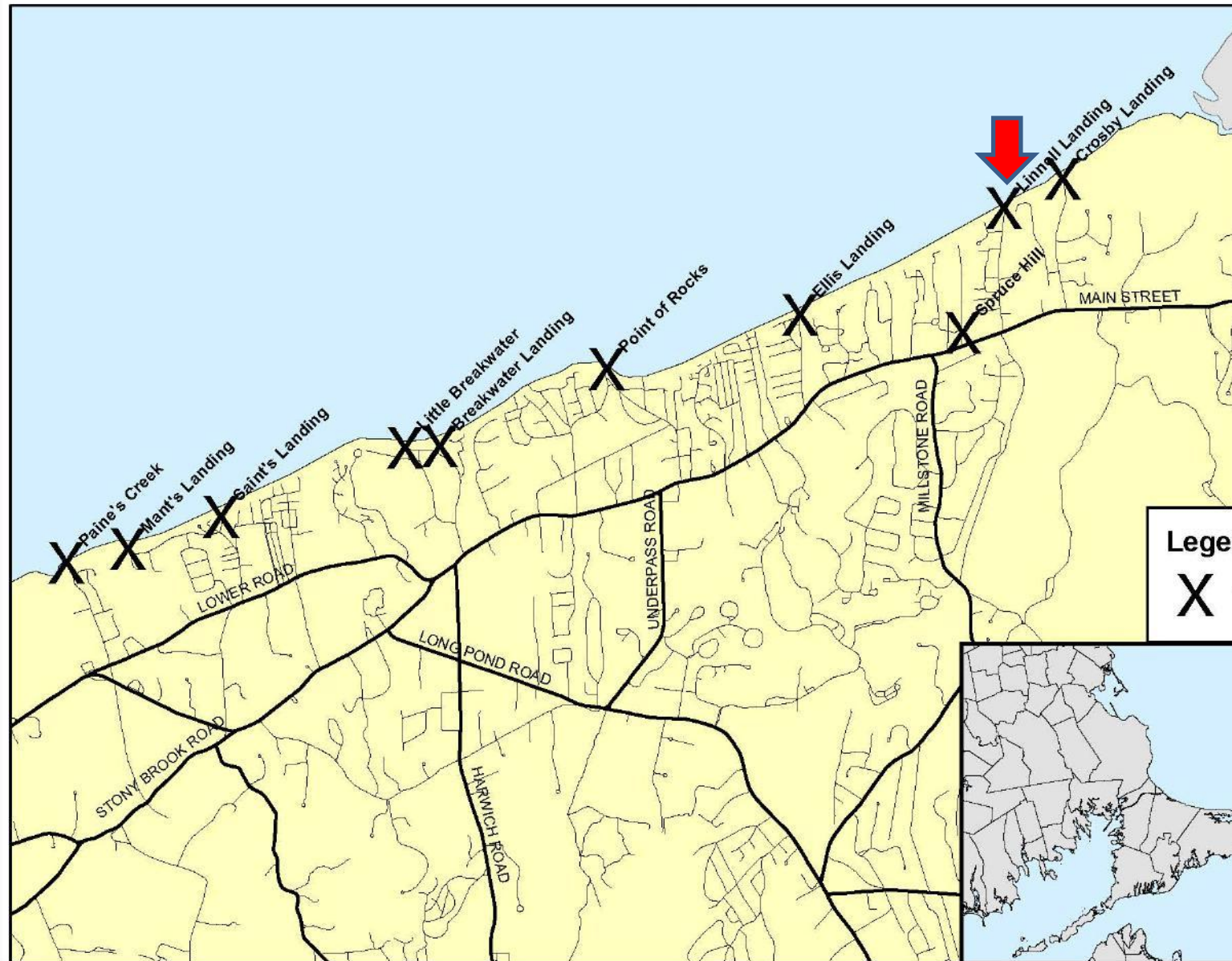
Other factors

- Stormwater basins to south along Ellis Landing Road, fall 2014.
- Sediment traps at junction with unpaved private roads.
- Protective of home to west, while also protective to dune habitat to east, but still allowing access to beach via a ramp.

Linnell Landing

- Stormwater (rain) discharges directly to beach





Legend

X Town Landings



Town of Brewster
Conservation Department

Brewster Town Landings
Parking Areas

0 1,500 3,000 6,000 Feet
1 inch = 3,000 feet

N

Linnell Landing



GENERAL NOTES:

1. SUPPLY ALL MATERIAL, EQUIPMENT AND LABOR FOR THE PROPOSED DRAINAGE IMPROVEMENTS AS DESCRIBED AND SHOWN ON PLAN AND DETAILS.
2. PERFORMANCE OF THE WORK SHALL BE IN COMPLIANCE WITH THE PLAN AND DETAIL ORDER OF CONDITIONS ISSUED BY THE BREWSTER CONSERVATION COMMISSION FOR THE REFERENCED PROJECT, CONSTRUCTION PROTOCOL, AND AS DESCRIBED BELOW.
3. ACCESS TO BE FROM THE LINNELL TOWN LANDING FOR MATERIAL AND EQUIPMENT. UPON COMPLETION, ALL DISTURBED AREAS TO BE RE-GRADED AND RE-VEGETATED TO MATCH PRE-CONSTRUCTION CONTOURS.
4. ANY FILL MATERIAL REQUIRED SHALL BE CLEAN COMPACTED COARSE SAND BROUGHT ONTO SITE BY CONTRACTOR.
5. FINAL GRADING PLAN SHALL BE APPROVED BY ENGINEER PRIOR TO CONSTRUCTION.
6. ALL UTILITY LOCATIONS SHOWN ON THE PLAN ARE APPROXIMATE. CONTRACTOR SHALL NOTIFY DESAFC AND BREWSTER WATER DEPARTMENT PRIOR TO START OF ANY WORK.

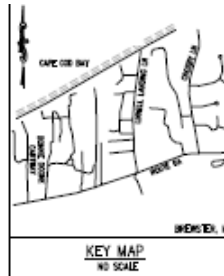
LEGEND

EXISTING

- WATER VALVE
- HYDRANT
- MISC. SIGN
- UTILITY POLE
- CONTOUR

PROPOSED

- CONTOUR
- SPOT GRADE



PLAN REFERENCES:

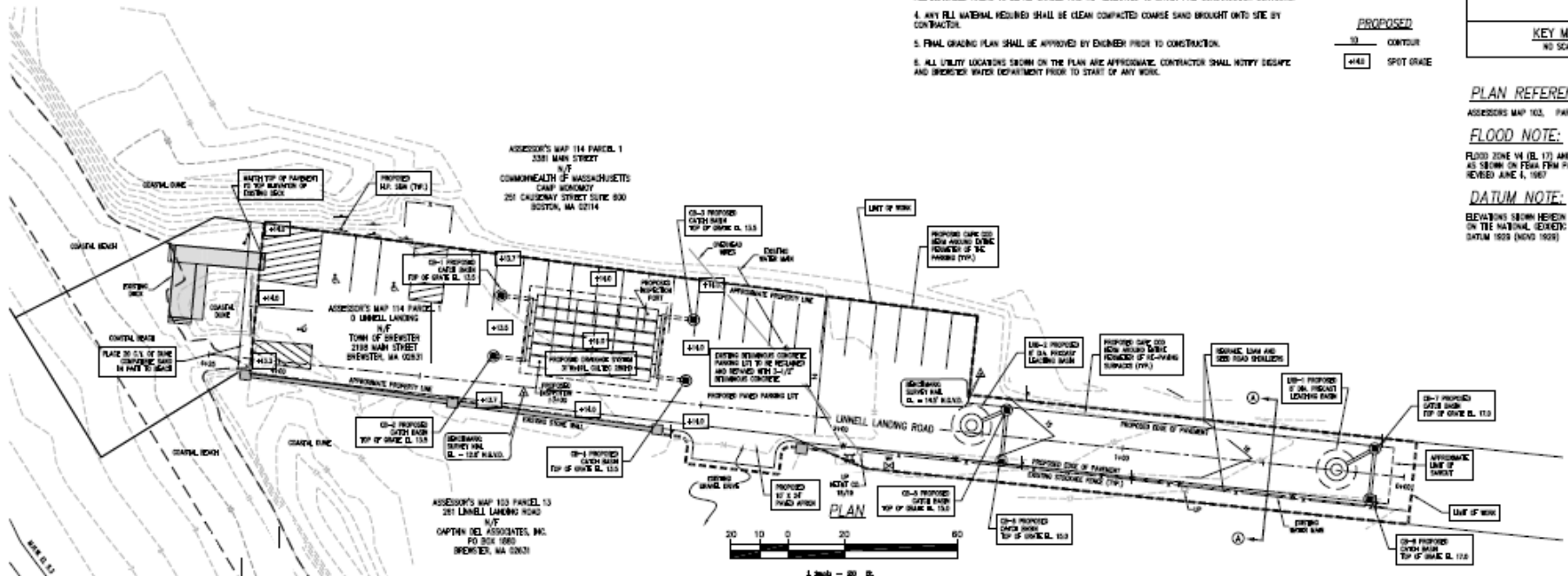
ASSESSOR'S MAP 103, PARCEL 14

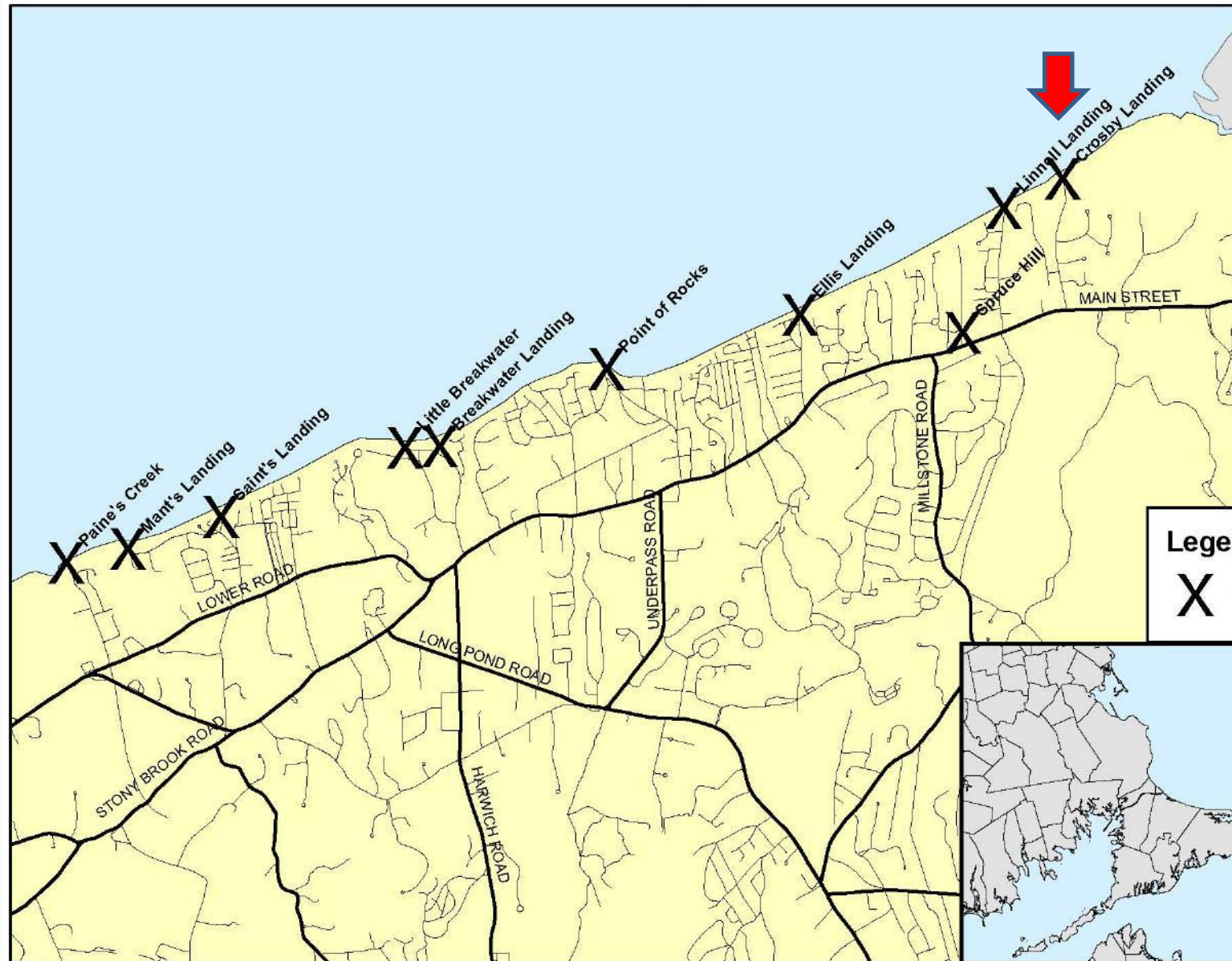
FLOOD NOTE:

FLOOD ZONE V4 (BL 17) AND ZONE 44 (BL 12) AS SHOWN ON FEMA FIRM PANEL 605003 0005 E REVISION A, 1987

DATUM NOTE:

ELEVATIONS SHOWN HEREIN ARE BASED ON THE NATIONAL GEODESIC VERTICAL DATUM 1929 (NGVD 1929)





Legend

X Town Landings



Town of Brewster
Conservation Department

Brewster Town Landings
Parking Areas

0 1,500 3,000 6,000
Feet
1 inch = 3,000 feet

N

PARKING AND ACCESS IMPROVEMENTS FOR STATE PROPERTY
FOR CROSBY MANSION, LINELLE LANDING AND CROSBY BEACH AREAS

 DEP wetlands

1 inch = 100 feet

300



Crosby August 2015





Crosby looking south



Linnell Landing



State property just east of Crosby



State property just east of Crosby



State property just west of Crosby



Looking south towards Mansion



Crosby Mansion and field



Old tennis courts



Old tennis courts





Short term concept









POT. PHASE I BIKE PATH
CONNECTOR TO NEW
DRIVE AND EX. ROAD

EX. CAPE REP
LIGHTED PARKING

CAPE REP
THEATER
(LEASE AREA
B, C AND D)

OUTDOOR
THEATER

CAPE REP
LEASE AREA
'A' LIMITS??
PROPOSED
22-24 FT WIDE
PEACH ACCESS
DRIVE

PROP 10 FT.
WIDE BIKE PATH

ROUTE 66

EX. BIKE SHOP

CAPE REP
THEATER

NEW
DRIVEWAY
ACCESS POINT

POTENTIAL BIKE PATH
CONNECTION - RT GA
LIGHTS

EX. PARKING

EXISTING CAPE COO RAIL TRAIL

POT. PHASE II
BIKE PATH &
CONNECTION TO
REP THEATER

MAINTENANCE
50 FT BUFFER

Other landings

- Fall 2015
 - Slough Pond Landing redesign
 - Fisherman's Landing stormwater/parking
- Ongoing
 - Long Pond Boat Ramp redesign

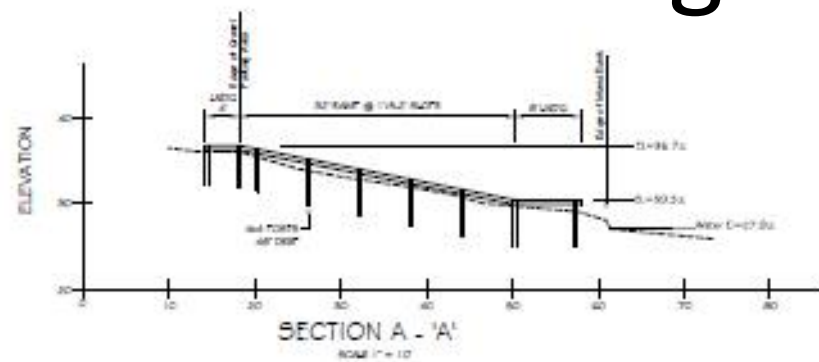
Slough Pond Landing



Slough Pond

- Eroding bank (wave action, boat launching)
- Eroding slope
- Unsafe conditions for launching car top boats
- Neighbor concerns
- Permitting in August/September 2015

Slough Pond Landing



NOTES:

ROAD SHOULDER:

1. THE EXISTING DIRT SHOULDER SHALL BE TOPPED WITH 4" THICKNESS OF GRAVEL AND BEDDED WITH A CONCRETE CURB (SEE NOTE 1).
2. THE EXISTING DIRT SHOULDER, MINUS THE DESIGNATED PARKING AREA, SHALL BE REMOVED AND REPLACED WITH 4" THICKNESS OF GRAVEL AND BEDDED WITH A CONCRETE CURB (SEE NOTE 1).
3. TWO PARALLEL ROWS SHALL BE INSTALLED ALONG ROADSIDE TO THE EAST OF THE GRAVEL PARKING AREA.
4. CONCRETE (OR THICKER) WHEEL STOPS ARE TO BE PLACED AS SHOWN ON THE PLAN VIEW. WHEEL STOPS ARE TO BE ANCHORED USING TWO PILES OF 4" REBAR PER STOP 3'UT LONG INTO THE GROUND.

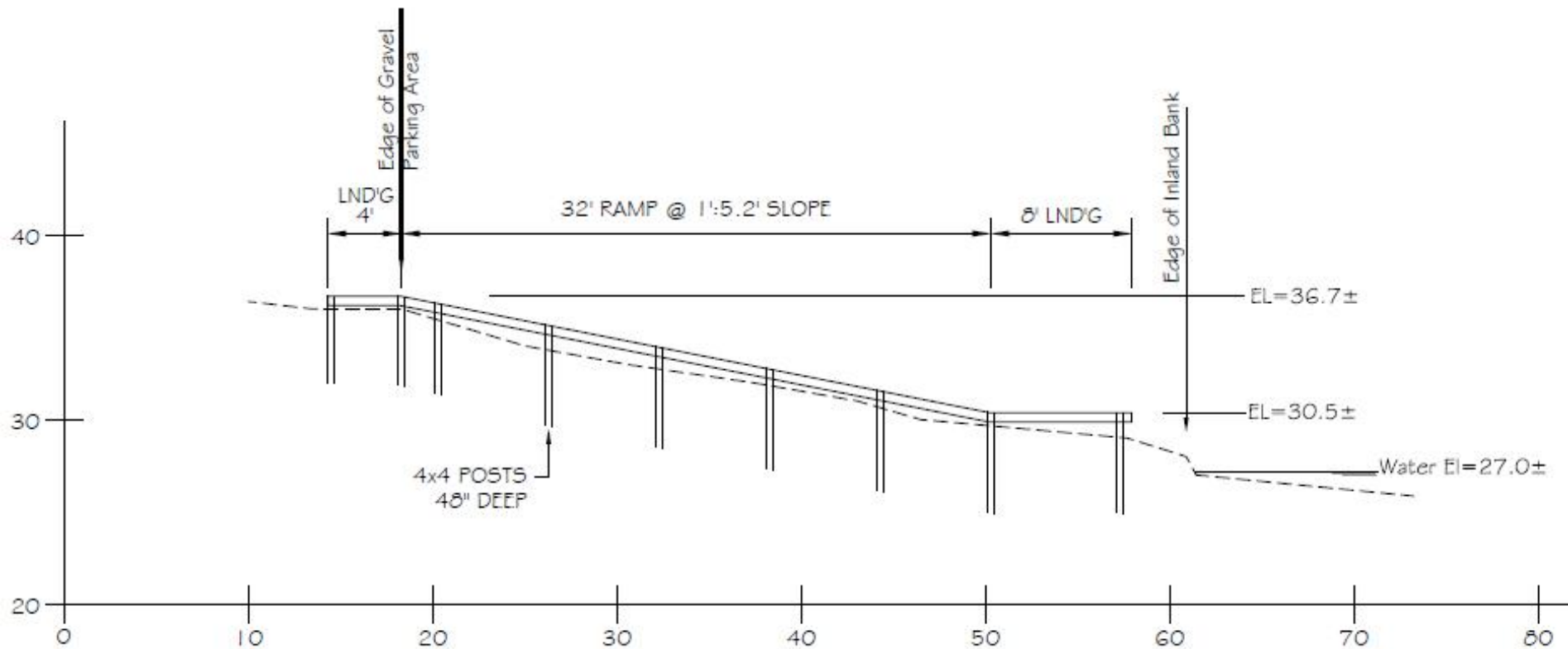
TIMBER RAMP:

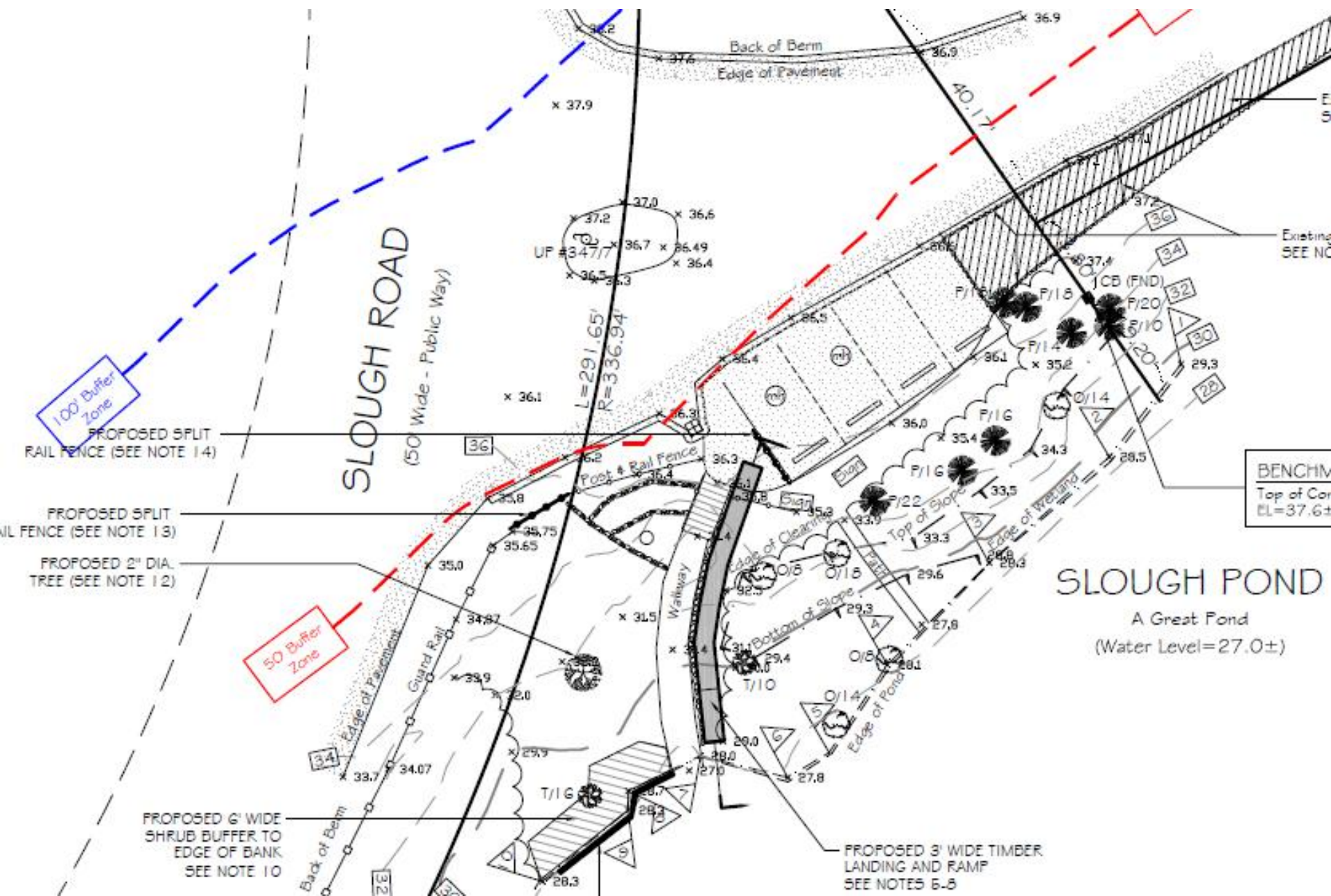
5. THE TIMBER RAMP SHALL BE CONSTRUCTED BY USING TWO PARALLEL TREATED PILES FOR JOISTS AND TWO DOCKING.
6. ALL WALKERS TO BE BUILT ON A TREATED ROADS OR OTHER APPROVED ROAD.
7. ALL DOCKING SHALL BE STAYED BY RACK.
8. ALL DOCKING SHALL BE FINISHED WITH A SMOOTH SURFACE.

CORR ROLL & REVEGETATION:

9. TWO (2) ROWS OF A 6" DIA COR ROLL SHALL BE INSTALLED ALONG THE EXISTING FACE OF THE ROAD RAMP. EACH ROW SHALL BE SECURED USING A FOOT LONG 1/2" GALVANIZED WIRE ROPE WITH MOORING AND TUCKING EVERY 4' ALONG. WIRE ROPE SHALL BE ONE PRICE AND HAVE 1/2" DIA ROPS SET A MINIMUM OF 10' FROM EACH OTHER.
10. A TOTAL OF 1/2" 2" 3" 4" 5" 6" 7" 8" 9" 10" 11" 12" 13" 14" 15" 16" 17" 18" 19" 20" 21" 22" 23" 24" 25" 26" 27" 28" 29" 30" 31" 32" 33" 34" 35" 36" 37" 38" 39" 40" 41" 42" 43" 44" 45" 46" 47" 48" 49" 50" 51" 52" 53" 54" 55" 56" 57" 58" 59" 60" 61" 62" 63" 64" 65" 66" 67" 68" 69" 70" 71" 72" 73" 74" 75" 76" 77" 78" 79" 80" 81" 82" 83" 84" 85" 86" 87" 88" 89" 90" 91" 92" 93" 94" 95" 96" 97" 98" 99" 100" 101" 102" 103" 104" 105" 106" 107" 108" 109" 110" 111" 112" 113" 114" 115" 116" 117" 118" 119" 120" 121" 122" 123" 124" 125" 126" 127" 128" 129" 130" 131" 132" 133" 134" 135" 136" 137" 138" 139" 140" 141" 142" 143" 144" 145" 146" 147" 148" 149" 150" 151" 152" 153" 154" 155" 156" 157" 158" 159" 160" 161" 162" 163" 164" 165" 166" 167" 168" 169" 170" 171" 172" 173" 174" 175" 176" 177" 178" 179" 180" 181" 182" 183" 184" 185" 186" 187" 188" 189" 190" 191" 192" 193" 194" 195" 196" 197" 198" 199" 200" 201" 202" 203" 204" 205" 206" 207" 208" 209" 210" 211" 212" 213" 214" 215" 216" 217" 218" 219" 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Ramp for car top boats





Fisherman's Landing



Fisherman's Landing

- Stormwater concerns; aging infrastructure, insufficient to capture stormwater
- Direct discharge to high quality waters of Sheep Pond
- Erosion to beach
- Concerns over parking for beachgoers versus fishermen
- $\frac{1}{2}$ owned by State, $\frac{1}{2}$ by Town

Fisherman's Landing

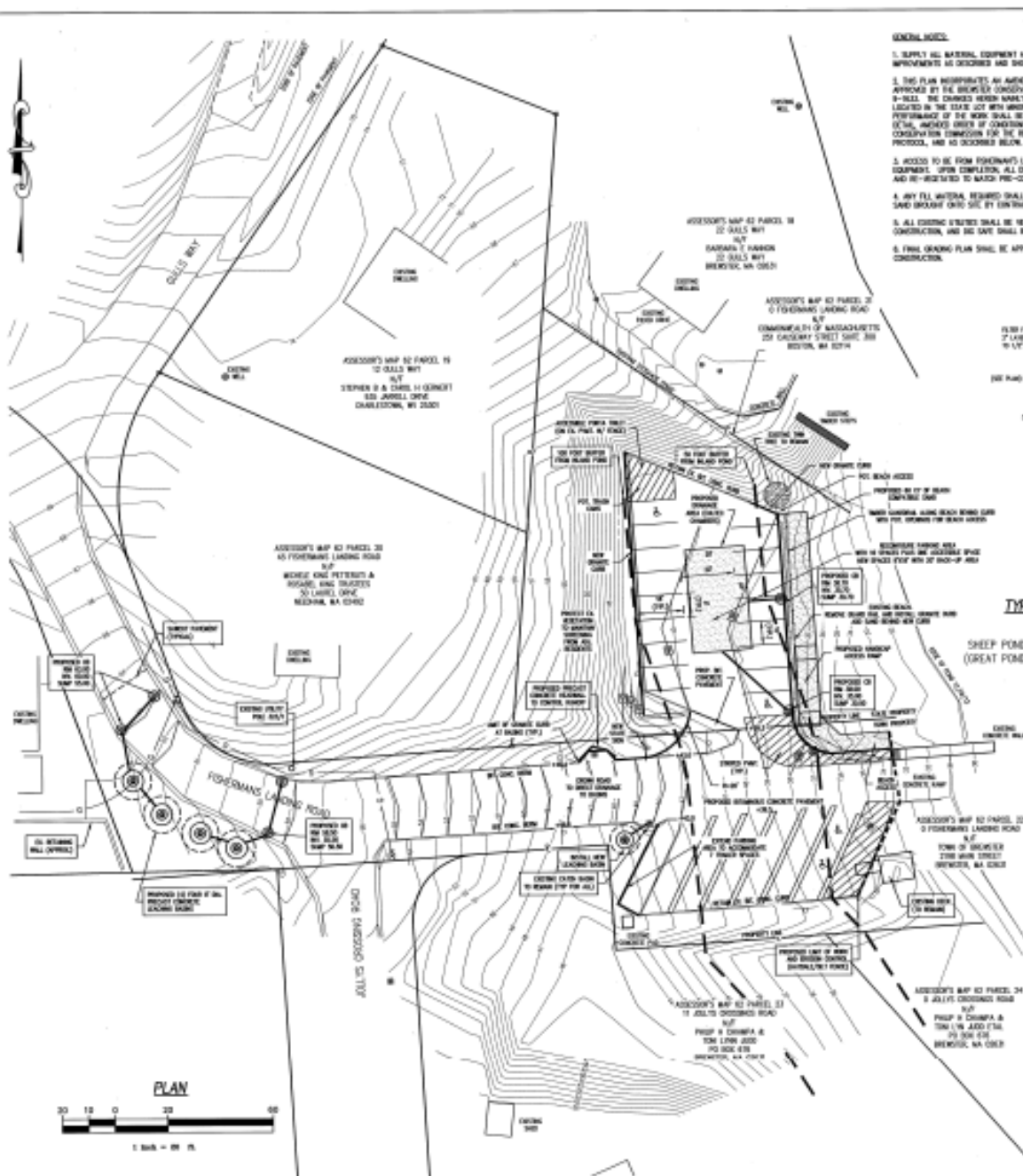


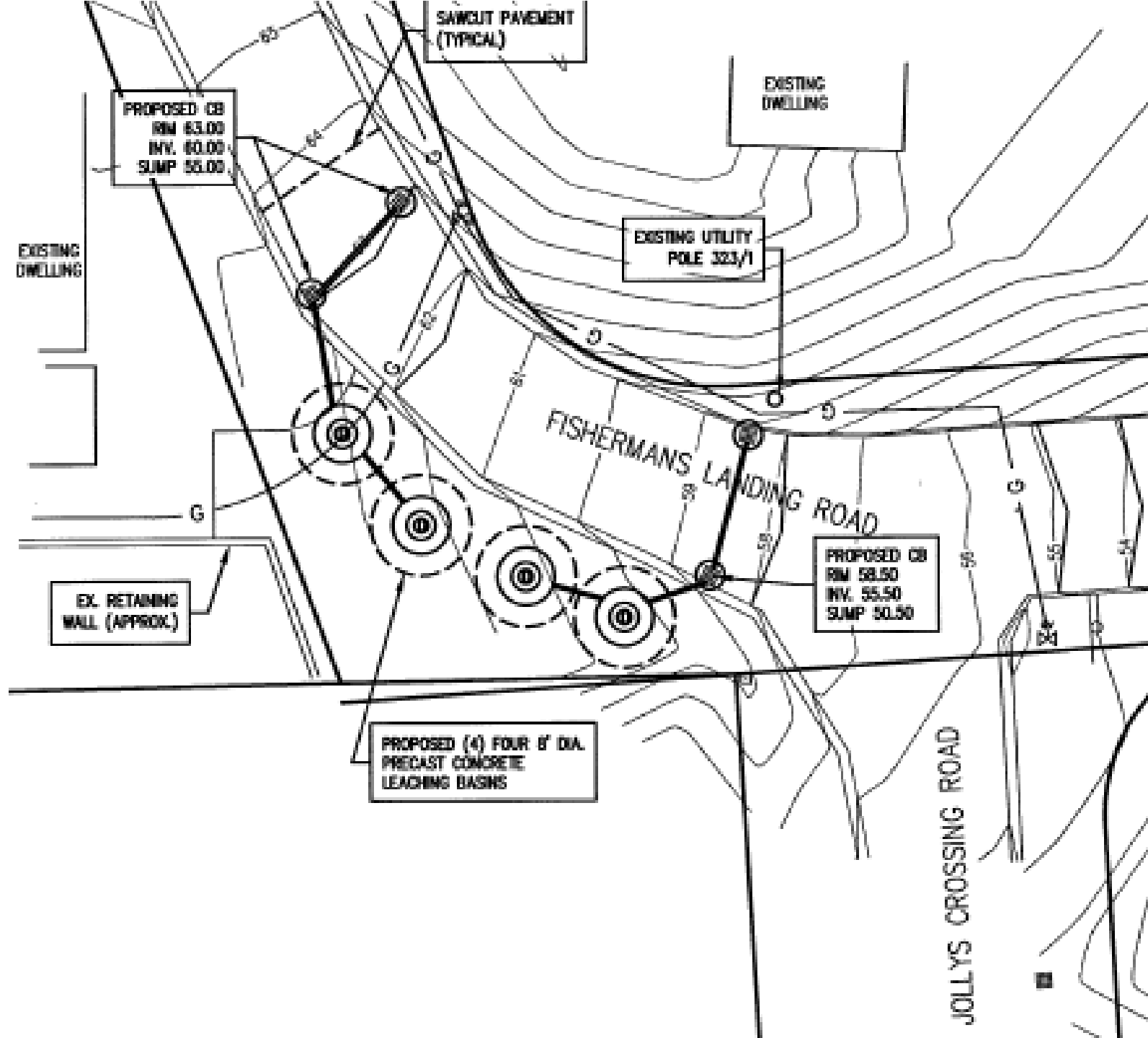
Fisherman's Landing

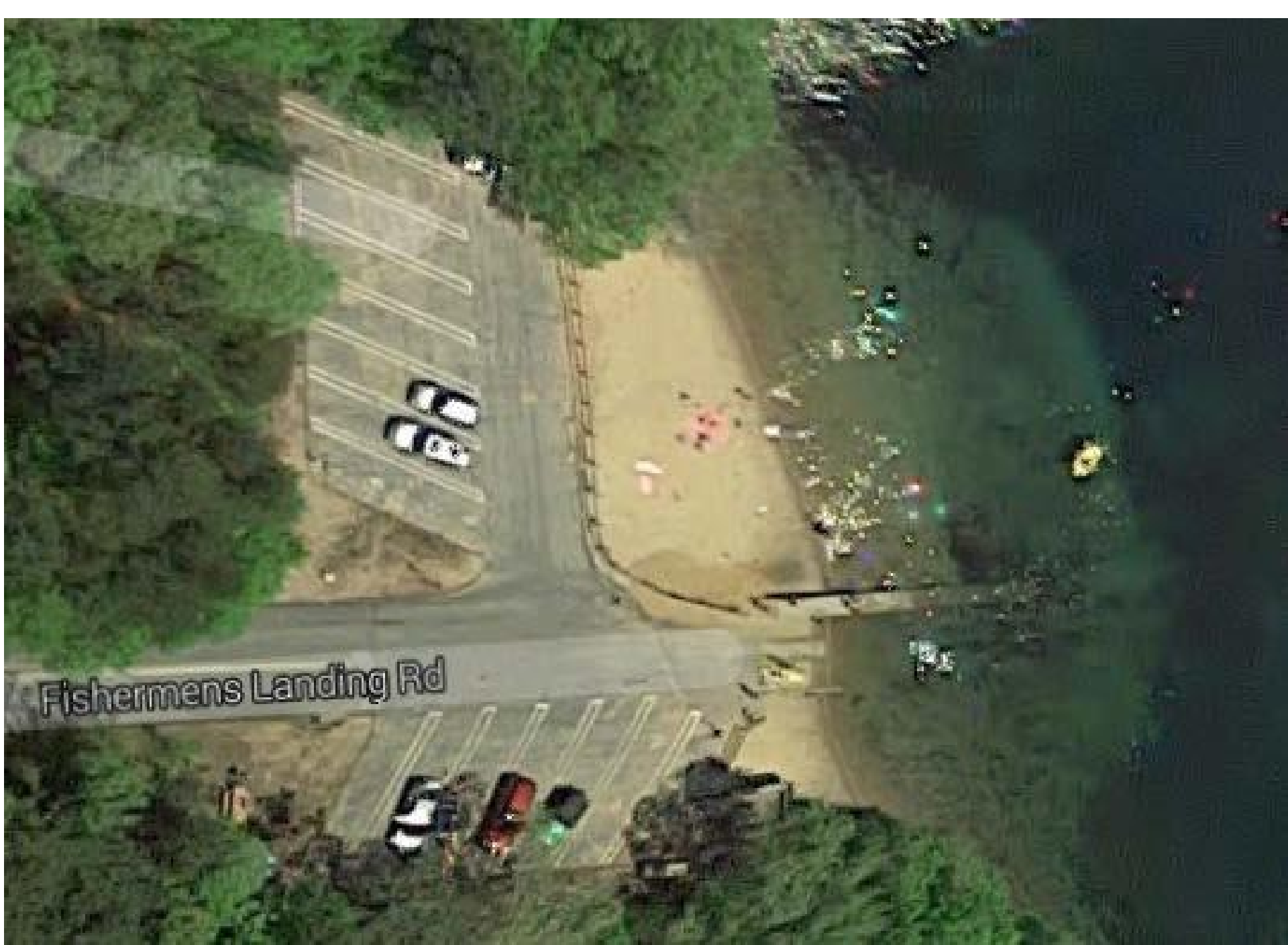


Fisherman's Landing

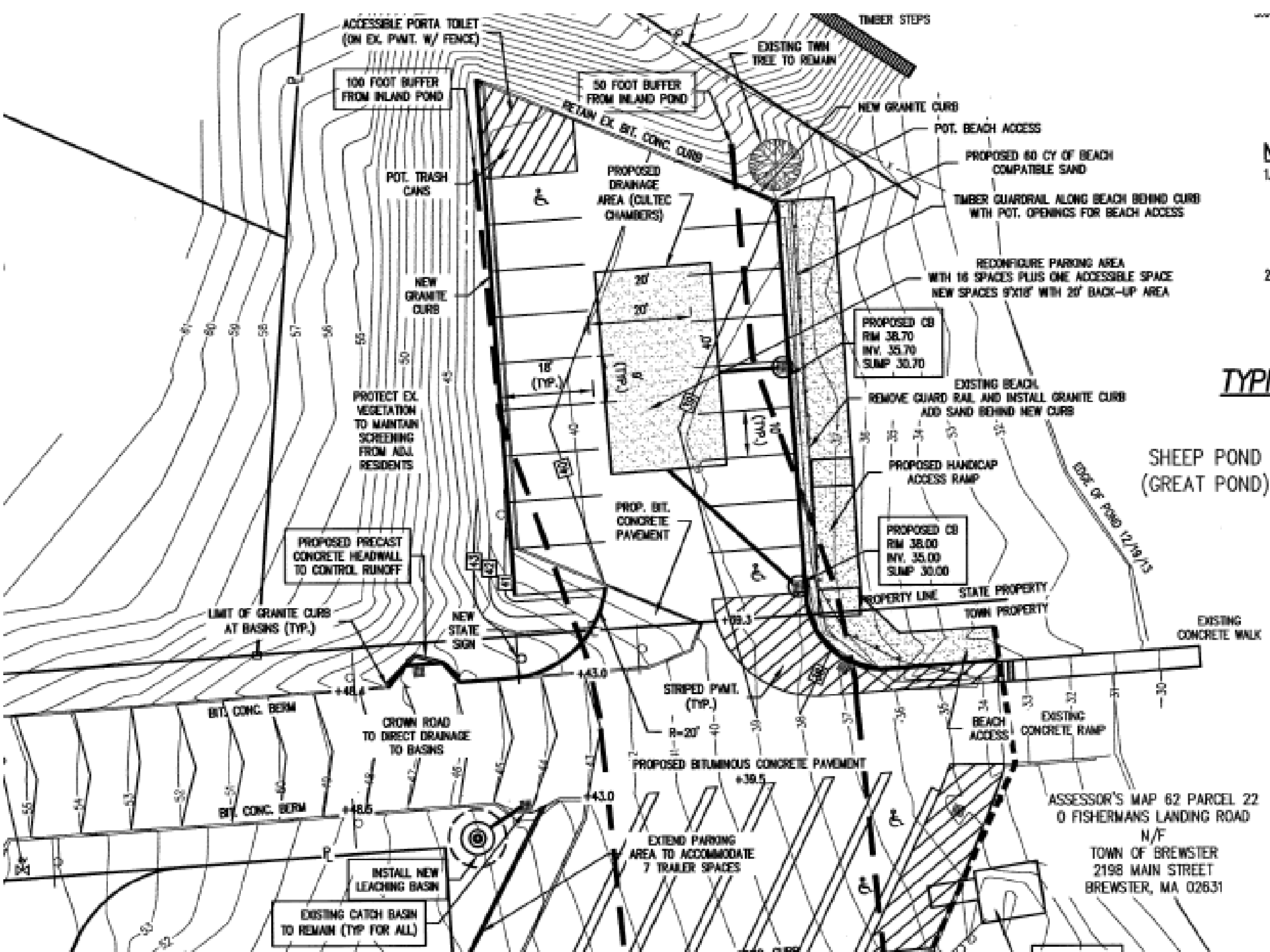








Fishermens Landing Rd



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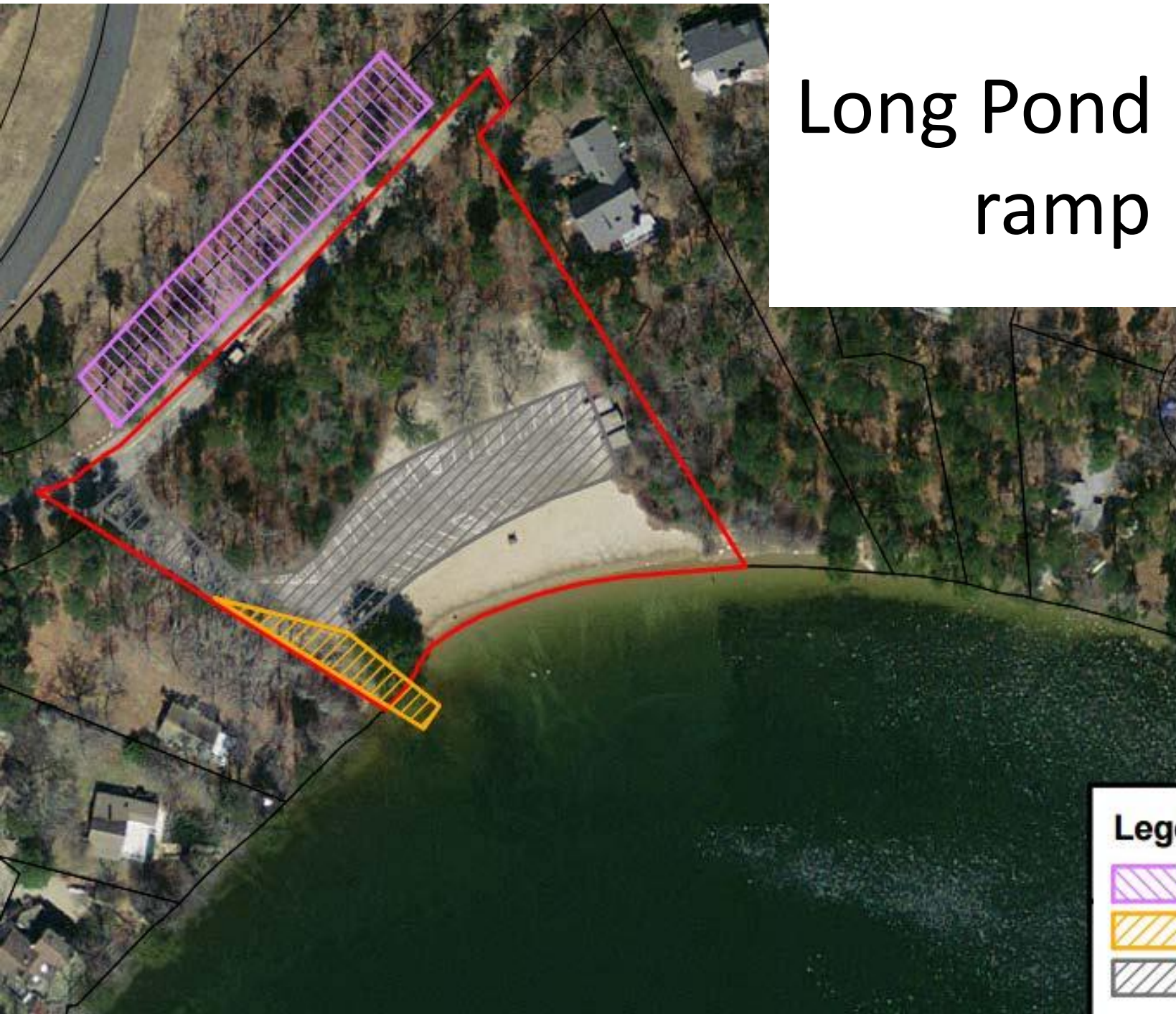
SHEEP POND (GREAT POND)

ASSESSOR'S MAP 62 PARCEL 22
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TOWN OF BREWSTER
2198 MAIN STREET
BREWSTER, MA 02631

Long Pond Landing and ramp



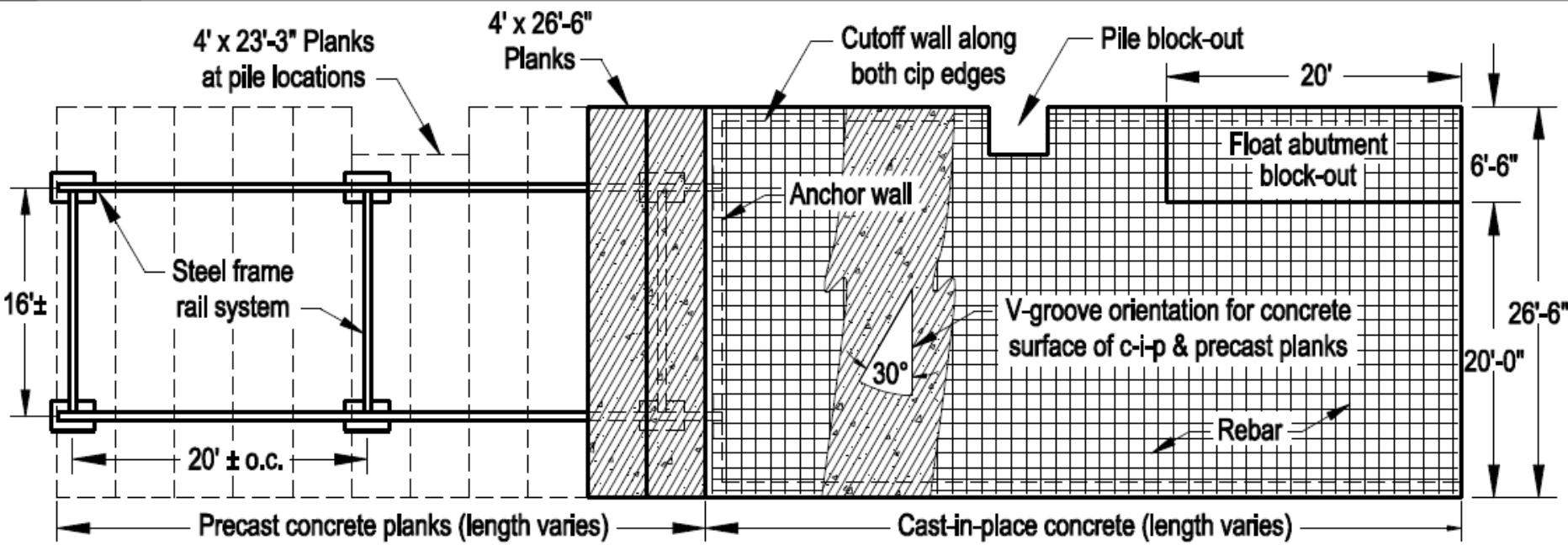
Long Pond boat ramp



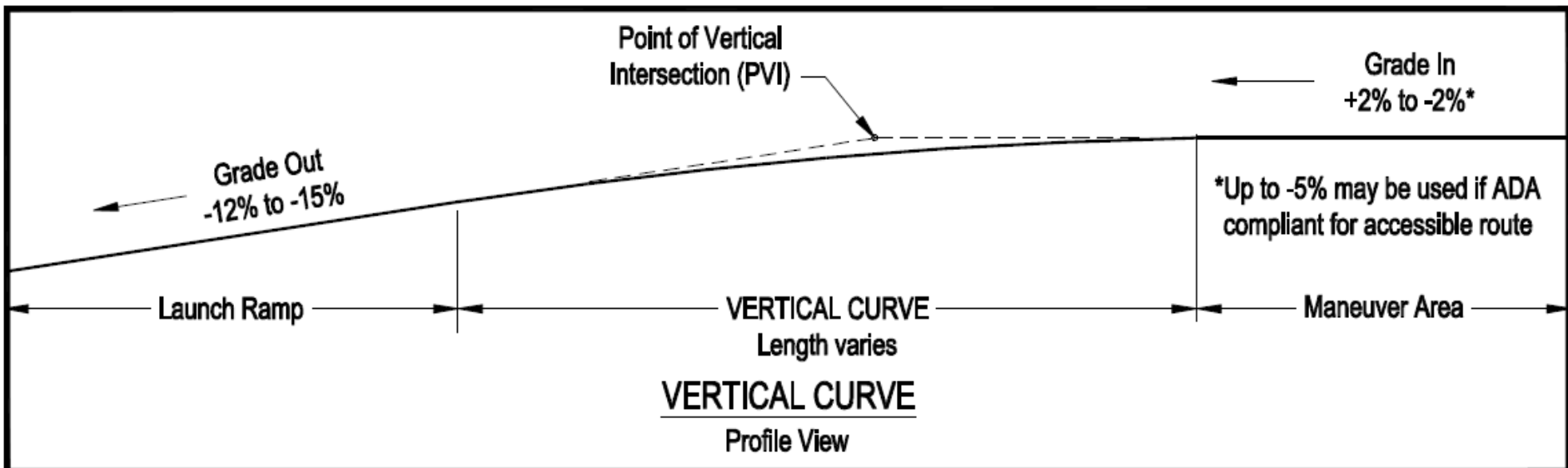
Legend

-  Trailer Parking
-  Boat Ramp
-  Parking Area





TYPICAL LAUNCH RAMP LAYOUT
 One-lane launch ramp with floats on side



VERTICAL CURVE
 Profile View

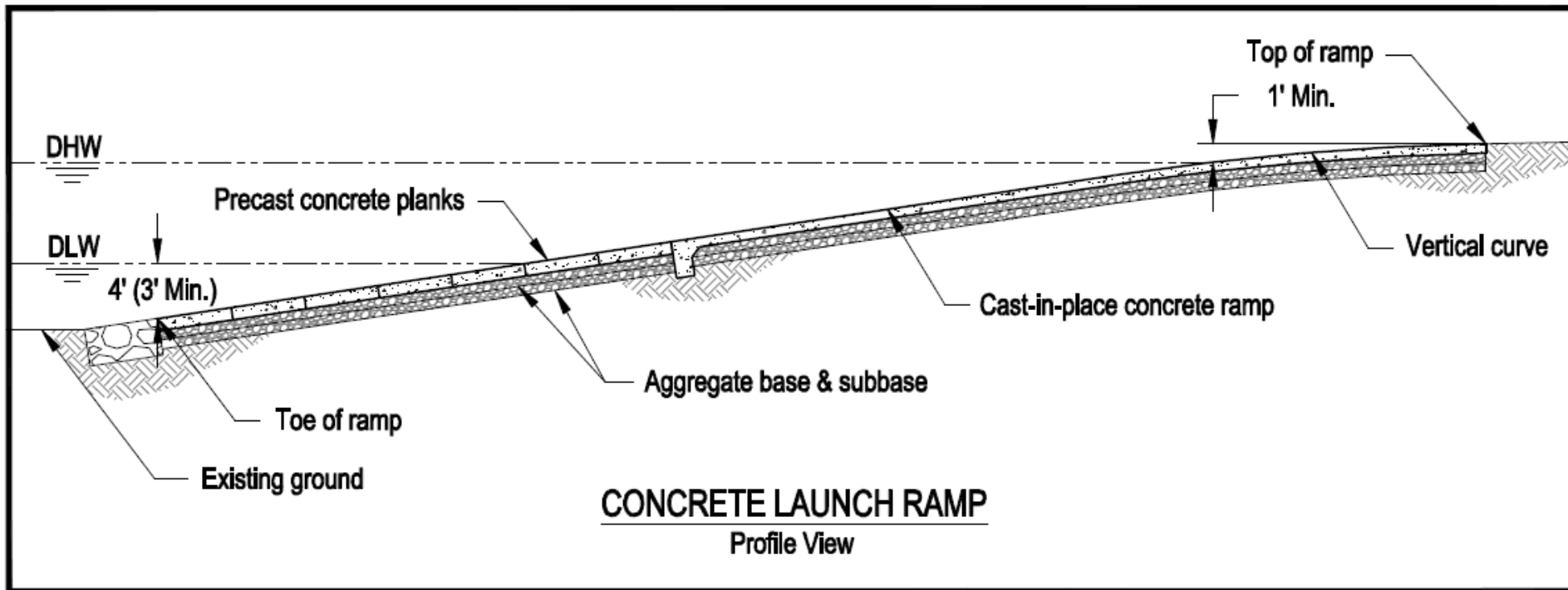


Photo 3-23 Precast concrete plank design elements